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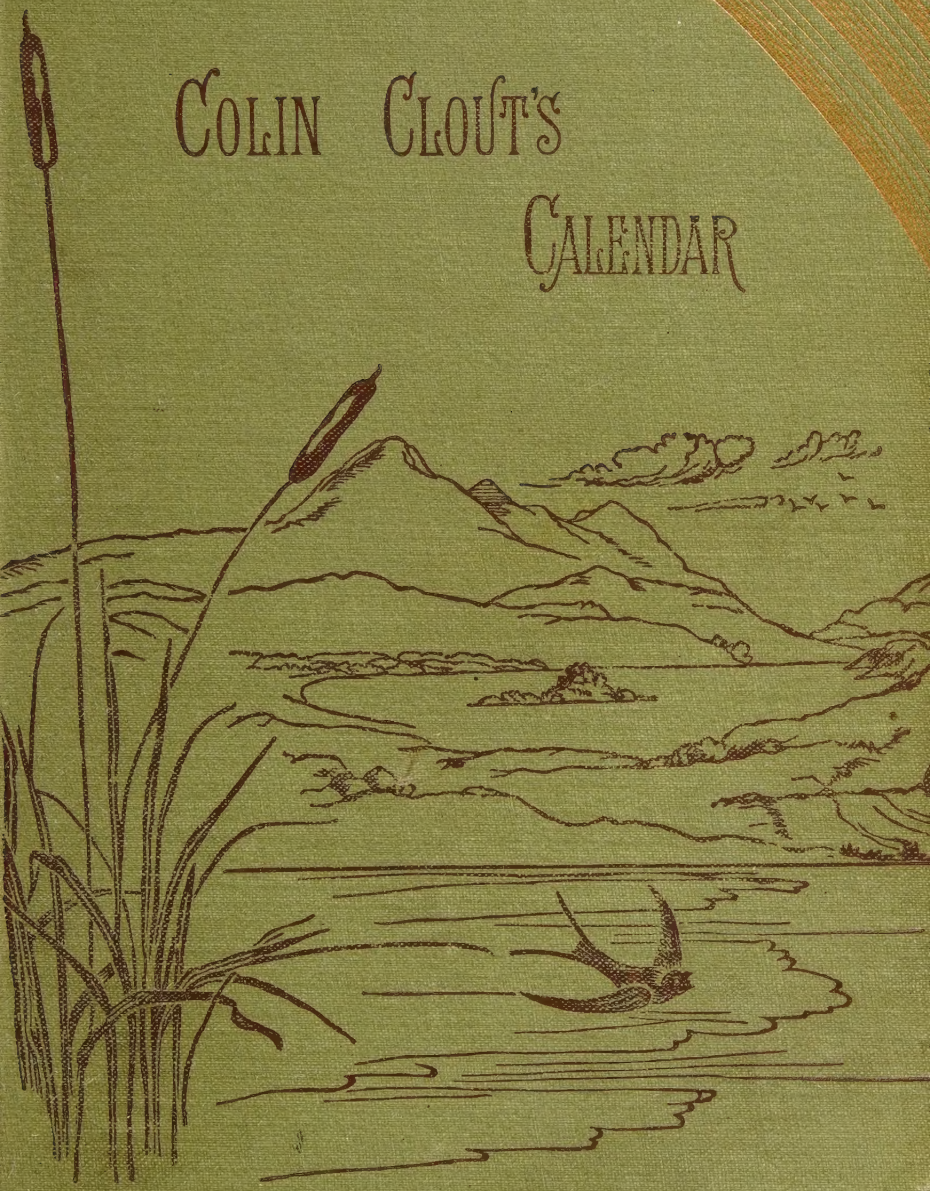

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COLIN CLOUT'S CALENDAR

THE RECORD OF A SUMMER

APRIL—OCTOBER

BY

GRANT ALLEN

AUTHOR OF

'THE EVOLUTIONIST AT LARGE' 'VIGNETTES FROM NATURE' ETC.

London

CHATTO & WINDUS, PICCADILLY

1883

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PREFACE.

THE little Essays which form this volume originally appeared in the 'St. James's Gazette,' and I owe many thanks to the Editor for his kind permission to republish them in their present form.

The greater number of the papers are botanical, and these, I hope, will be found to contain some new and original evolutionary views. The remainder, dealing with the animal world, though not, I trust, mere transcripts, owe more to such previous and more serious works as those of Mr. Darwin, Mr. A. R. Wallace, Mr. Herbert Spencer, and Professor Weismann. I ought also to express my indebtedness in the botanical portion to Dr. Bentham, Sir Joseph Hooker, Professor Sachs, and other standard authors.

G. A.

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COLIN CLOUT'S CALENDAR.

I.

PRIMROSE TIME.

YESTERDAY, April showers chased one another across the meadows all day long, coming and going between interludes of fathomless blue sky and vivid sunshine, the fleecy clouds being driven like sheep before a collie by the brisk south-westerly breezes. To-day, the Fore Acre is smiling accordingly with lusher grass, and the bustling bees are busier among fresher and sweeter primroses. For the Fore Acre is not a level field, like most others on the farm: it slopes down in broken terraces from the barton to the banks of Venlake, as we call our little streamlet in the valley below; and it is the slope that makes it the best spot near the homestead for primroses to grow on. These pet fancies and predilections of the flowers, indeed, are not without full and satisfactory reasons of their own. The plant chooses its proper haunt with due regard to its special needs and functions. It seeks warmth and shelter in some cases; bracing moorland air in others; moisture and shade, or sun and open space, according to the

peculiar tastes and habits it has inherited from its remotest ancestors. We lordly human beings are, perhaps, too apt to overlook the essential community of life and constitution between ourselves and the plants. We under-estimate their unconscious intelligence and their guileless cunning; we forget that in their insentient fashion they plot and plan and outwit one another with almost human semblance of intentional strategy. Yet those of us who live much in their society learn at last to recognise that there is a meaning and a purpose in everything they do—a use for every little unnoticed point of structure or habit in their divinely ordered economy. Even the very date of their flowering has a settled purpose of its own, and bears some definite reference to the insect that brings the pollen, or to the time needed for ripening and setting the seed. To watch the succession of these little members of the floral commonwealth, to learn the connection in which they stand to one another, and to interpret the purpose that they severally have in view—these are the great problems and the self-sufficing rewards of those who slowly spell out for themselves from living hieroglyphics the emblems of the country calendar.

See from the edge of the hillside here how the primroses cling, as it were on purpose, to the tumbled slopes and banks of the Fore Acre, leaving almost flowerless the level platforms of terrace between them. Each little bank or escarpment is a perfect natural flower-bed, thickly covered from top to bottom with beautiful masses of tufted yellow bloom. But in between, on the intermediate grassy bits, there are no primroses: or, to speak more correctly, all the primroses there are cowslips, their

tall scapes not yet much more than just raised above the level of the greensward. For at bottom primroses and cowslips are really identical: even the old-fashioned botanists have freely allowed that much, and have re-united the two varieties as a single species under a common name. The leaves are absolutely indistinguishable, as you observe when you look closely at them; the structure of the individual flowers is the same in all important points: they only differ in the arrangement of the blossoms on the stem; and even in that the two forms are connected by every intermediate stage in the third dubious variety known as the oxlip. Why, then, do cowslips differ from primroses at all? For a very simple yet ingenious reason.

The true primrose almost always grows on a bank or slope, where its blossoms can readily be seen by the bees and other fertilising insects without the need for any tall common flower-stalk. Hence its stalk is undeveloped, as the scientific folk put it—in other words, it never produces one at all to speak of. Each separate primrose springs by a distinct stem from a very stumpy and dwarfish thick little stock, which represents the same organ as the long and graceful stalk of the cowslip. This stock is so short that it is quite hidden by the close rosette of downy wrinkled leaves; but if you examine it carefully you will see that the flowers are arranged upon it in an umbel or circular group, exactly like that of its taller and slenderer nodding relative. Each primrose blossom is also larger, so as more easily to secure the attention of the passing bee. In the cowslip, on the other hand, growing as it usually does on level ground, the common stalk has acquired a habit of lengthening

out prodigiously, so as to raise its clustered bunch of flowers well above the ground and the surrounding grasses, and thus catch the eye of some roaming insect, who could never have perceived its buried blossoms if they were laid as close to the grass-clad earth as in the case of the neighbour primroses. The two varieties have now become practically almost distinct, because each naturally sticks to its own best-adapted haunts, and is usually crossed only by pollen of its own kind. But the oxlip is a sort of undecided *tertium quid*, an undifferentiated relic of the old undivided ancestral form, which grows in intermediate situations, and crosses now with one plant and now with the other, so preventing either from finally taking its stand as a truly separate species.

The reason why the thorough-going primroses do not cross with the thorough-going cowslips is easy enough to understand : they are seldom both in blossom together. This, again, naturally results from the form and habit of the two flowers. In both, the head of bloom is produced from material laid by during the past year in the perennial rootstock ; and in both, the buds begin to sprout as soon as the weather grows warm enough for them to venture forth with safety. But the 'rathe primrose' bursts into blossom first, because it has only to produce short subsidiary stalks for each separate flower ; the cowslip lingers somewhat later, because it has to send up a stout common stem, besides forming the minor pedicels for the individual cups. Their other differences are all of similar small kinds. The primrose, standing straight up from the earth, receives the fertilising bee or butterfly on the face of its wide open corolla ; the cowslip, a little pendulous by nature, re-

ceives its guest from below, or from one side, and so has its blossom more bell-shaped as well as less widely expanded. The primrose is pale to suit its own special insect visitors ; the cowslip is a deeper yellow, melting almost into orange, to meet the tastes of a somewhat different and perhaps more daintily æsthetic circle. At bottom, however, both flowers are very nearly the same, and their peculiarities are all specially intended to insure a very high type of cross-fertilisation.

Observe that in both flowers the corolla, though deeply divided into five notched lobes or sections, is yet not really composed of separate petals, but tapers beneath into a very long and narrow tube. Cowslips and primroses belong by origin to the great division of five-petalled flowers ; for all blossoms originally had their parts arranged either in sets of threes or in sets of fives ; and this distinction, though often obscured, is still the most fundamental one between all flowering species. But in the primrose, as in many other advanced types, the five primitive petals have coalesced at their bases into a single tube, so as to make the honey accessible only to bees, butterflies, and other insects with a long proboscis, who could benefit the plant by duly effecting the transfer of pollen from the stamens of one flower to the sensitive surface of another. In blossoms with open petals many thieving little creatures come in sideways and steal the honey without going near the pollen at all : in a better adapted flower like the primrose such a mischance is rendered impossible.

Notice, too, that in both varieties the eye or centre of the corolla is deep orange, while the outside is lighter in tone. This difference in colour acts as a honey-guide,

and directs the bee straight to the mouth of the tube at whose base the nectar is stored. And now again, let us cut open one or two flowers of each variety, so as to lay bare the interior of the tube. See, they have each two separate and corresponding forms, known long ago to village children as the thrum-eyed and the pin-eyed primroses or cowslips. In the pin-eyed form the long head of the pistil, looking for all the world like an old-fashioned round-headed pin, reaches just to the top of the tube, and forms the prominent object in the centre, while the five stamens are fastened to the side of the tube about half-way down. In the thrum-eyed form, on the contrary, the stamens make a little ring at the top of the tube, while the pin-headed summit of the pistil only reaches just half-way up the tube, exactly opposite the same spot where the stamens are fixed in the other sort. When the bee begins by visiting a thrum-eyed blossom, she collects a quantity of pollen on the hairs at the top of her proboscis. If she then visits a second flower of the same type, she does not fertilise its pistil, but only gathers a little more pollen. As soon, however, as she reaches a pin-eyed blossom she unconsciously deposits some of this store of pollen on the sensitive surface or pin of its pistil ; while at the same time some more pollen, half-way down the tube, clings to her proboscis, and is similarly rubbed off against the pistil of the next thrum-eyed blossom she chances to visit. The exact correspondence in position of the various parts in the two diverse forms admirably insures their due impregnation. Thus each blossom is not only fertilised from another flower, but even from a flower of an alternative type, which is a peculiarly high modification of the ordinary method.

II.

THE RETURN OF THE SWALLOWS.

LAST week's showers, much longed for and anxiously expected after the apparently endless spell of bitter east winds, have brought out the meadows at last into the full fresh green of early spring. The buds upon the horse-chestnuts, which stood idle and half-open for so many days, have now finally burst forth into delicate sprays of five-fingered foliage ; and the young larches among the hillside hangers are revelling in the exquisite and tender freshness of verdure which larches alone can exhibit, and even they only for two short weeks of April weather. As for the hedgerows, I really think I can never recollect anything to equal them. The innumerable pecks of March dust from which we have been suffering seem to have brought forth gold enough in the celandines and crowfoots for many royal ransoms ; and the masses of primroses on the sunny banks are both thicker in tufts of bloom and with larger individual blossoms than I ever before remember to have seen them. The copses on Wootton Hill are carpeted with daffodils, wood-anemones, and hyacinths, in great patches of yellow, blue, and white ; and it is no wonder that to-day I should have seen the swallows, enticed back from their winter

quarters in Algeria by the sun and the flowers, flying low above the gorse and the violet-beds in the undercliff, where they may now catch hundreds of small insects on the wing around the honey-bearing blossoms which attract them out of their cocoons upon these warmer and brighter mornings.

What marvellous complexity of interaction and mutual relations between all the parts of nature and organic life this familiar fact of the swallows' yearly return implies for us! Hard-billed seed-eating and berry-eating birds, or mixed seed-eaters and insect-eaters, can manage to find food for themselves in England all the year round. Nay, even those species which live mainly upon worms, slugs, and other hardy small deer, can pick up a living somehow or other through our northern winters. But pure fly-catchers, like the swallows, must starve during the five months when winged insects are almost wholly lacking in temperate climates. Thus it becomes a matter of necessity with them to move south at the beginning of autumn, towards the orange groves of Italy and the palms of Africa. Before they can return, there must be insects in the north; and these insects must have been hatched from the egg, and re-hatched from the chrysalis stage, before they are fitted to become food for swallows, since swallows feed only on the wing. Accordingly, it is not until the spring flowers are well out, and the winged insects have begun to suck their honey, that the various species of the swallow family make their appearance.

The true swallows come first, and, taking one year with another, the second week of April may be taken as the average date of their return to the south-western

counties of England ; but this year the spring, in spite of its early promise, has hung fire a little in a curious half-hesitating way : and so I have not seen the first swallow till this morning. The swifts, larger and stronger birds, which fly even more incessantly than their cousins and therefore require a more abundant food-supply, do not usually come northward till the beginning of May, when the flowers and insects are in full force ; and they leave us again in August, while the swallows linger on till the late autumn. Both kinds fly low and open-mouthed over the most flowery meadows, where they catch honey-sucking insects in abundance : or over the ponds and rivers, where they meet with innumerable mayflies and other winged species, whose larvæ live as caddis-worms or the like under water, while the perfect insects hover above it to lay their eggs upon the surface.

The question as to the supposed instinctive feelings which drive the swallows north or south at the proper season is an extremely interesting one : and perhaps only very recent views as to the nature of climatic changes and zones can enable us in time to give the true explanation. Hitherto it has been usual to think of the differences of climate between Europe and Africa as though they had always been permanent, and so to raise unnecessary difficulties in the way of a rational solution to the problem. If England had always had a cold winter, while Algeria always had a warm one, and if a double belt of sea had always separated us from the two continents, it would indeed be hard to understand how an English bird could first bethink itself of moving southward in winter, or how an Algerian bird could ever be seized with an original impulse to go northward in

the spring-time. It is not surprising, therefore, that early naturalists should have taken refuge in the hypothesis of a special instinct implanted in the swallows, independently of experience, and prompting them to seek the appropriate climate by some unknown 'sense of direction' at the proper times of year. But, with our existing knowledge as to the past history of European geography and meteorology, no such cutting of the Gordian knot is now necessary.

We know that the climate of England in comparatively recent times was apparently as warm as that of North Africa; and we know that at the same period the beds of the Mediterranean and the English Channel were dry land. Hence it was then at least as easy for the swifts and swallows to range from Scotland to Sahara as it now is in America for the hardier humming-birds to range from Canada to Mexico. But when the change of 'cosmical weather' made England by slow degrees too cold in winter for flowers and midges to flourish all the year round, the swallows would begin gradually to fly a little to the south, as each autumn came on, and remove a little to the north again as spring returned. At first, no doubt, they would only have to shift their quarters very slightly in search of more plentiful food, without themselves being conscious of any special migration. In course of time, however, as the difference in climate became more and more marked, the birds would have to fly further and further south with each successive autumn, and would be enticed further and further north again to their original homes with each successive spring. Thus at last the practice of migration would become engrained in the nervous system, and

would grow into what we ordinarily call an instinct—that is to say, an untaught habit. This is the stage at which the migratory custom has always remained in America, where broad stretches of land extend from the Arctic region to the tropical forests, unbroken by any intermediate zone of severing sea.

In Europe, however, special circumstances have added another and more complicated element to the problem—the element of discontinuity. The Mediterranean, the English Channel, and the Baltic practically cut off the various parts of the swallows' summer hunting-grounds from their African wintering-places. To get from England to Algiers, many swallows fly over wide expanses of sea, far too broad to see across, and therefore quite destitute of landmarks. It is simple enough to find one's way by land from Canada to Mexico; but it is quite another thing to find one's way across the sea, without a compass, from Algeria to Marseilles: yet this is the route annually taken by one large body of northward-bound swallows. Dr. Weismann, however, has suggested an ingenious and fairly satisfactory explanation of the difficulty. He points out that the lines taken by the swallows and other migratory birds correspond on the whole with the shallowest parts of the Mediterranean, where it is most intersected by peninsulas and islands. When the Mediterranean valley began to sink below the sea-level it must at first have produced two or three large lakes in the deepest portions of its bed; and between these lakes there must have been connecting belts of land, now marked respectively by Sicily and Italy, by Sardinia and Corsica, and by Gibraltar and

Tangiers, with their uniting submarine banks. Of these the Spanish belt is still almost entire, and it offers no special difficulty: the others are now broken up into peninsulas or islands. Dr. Weismann supposes that various flocks of birds grew accustomed to proceed north or south along one such connecting belt, while the land was still in process of subsiding: and that their descendants still continue to follow the same lines till they reach the final headlands, and then fly straight over sea in a definite direction till they sight the opposite land. The younger birds follow their elders: while the elders themselves have learned the proper landmarks and directions from similarly following their own predecessors, and gradually take the lead in their turn as the seniors drop off one by one. Thus, if we may believe so plausible a theory, by a sort of unconscious hereditary teaching the memory of the lost land-connections has been handed down from one generation to another since pre-glacial times. Were Corsica and Sardinia now to sink slowly beneath the waves, it is not difficult to conceive that the swallows might still gather yearly upon the hills at Mentone, and fly southward across the blank space to Tunis under guidance of their most experienced elders.

III.

THE BEGINNINGS OF SPRING.

In spite of the severe and long-continued cold, the trees and flowers themselves seem to have made up their minds that we are to have an early spring—at all events here in the west country. The difference in the general forwardness of vegetation between the two great slopes on either side of England is this year extremely marked. In Kent and Sussex the buds are still closely covered in their dusky winter coats ; the flowers (save primroses) have hardly begun as yet to straggle here and there in a tentative way through the long-frozen soil ; and there is scarcely a sign anywhere among the meadows or copses that spring has set in at last. But in the south-western counties it is quite otherwise. The gardens here are gay already with bright golden borders of crocus ; snowdrops are flourishing in the open air ; and jonquils and daffodils are sending up their pale yellowish green leaves, enclosing their tall scapes with the papery spathes half revealing the slender buds within. On the horse-chestnut trees the dark gummy sheaths are just beginning to open under the pressure of the wan and growing leaflets which they have covered through the winter season ; the hardier shrubs are already well in

leaf, though the blades are still folded together or only half expanded as yet; and even on the hedges the white-thorns are showing signs of life, the little fresh pink scales bursting through their brown and withered coverings, or even sometimes showing a tiny green tip at the very end of a growing bough. When I break off the smaller branches I can see by the bright green and sappy look of the inner bark that the bushes are actively engaged in putting forth chlorophyll, and that a few days more of these warm westerly breezes will bring out the buds into leaves, at least in the sheltered southern hollows and combes.

This wide difference of climate between the Atlantic slopes—open chiefly to the influences of the Gulf Stream and the warm breezes which blow across it—and the eastern half of Britain, which lies right in the teeth of the Siberian east winds, has even stamped itself permanently on the character and distribution of our flora. Many of our plants of warmer types are only found in the south-west. The high moor, on which I have come out to-day for my morning's stroll, covered even now by little white and short-stemmed daisies—they will grow taller and pinker as the spring advances—is Claverton Down: and Claverton Down is the only station in England for a particular species of hairy spurge, of which in fact I am now in search.

It is not in itself a particularly interesting plant, being very little different from the other spurges, all of which are mere rank woodland or wayside weeds, with curious green and black flowers, more noticeable to the botanist than to the ordinary observer. But the fact that it is found nowhere else in Great Britain except on

this spot, one of the warmest and most forward hill districts in the south of England, gives it an adventitious value for every collector, and a real one for the student of botanical history. Evidently, the hairy spurge grows here, and only here, because, being a mountain species of warmer climates, Claverton Down is the only hill in Britain at once high enough and warm enough to suit it. This explanation sufficiently accounts for its absence elsewhere, but not quite for its presence here. How did it get from the Continent to Claverton Down?

If the occurrence of the hairy spurge in England were an isolated case, we might suppose that it had been accidentally imported by man, or that the seed had been blown here by the wind, or that it had been carried over by clinging to the feet of birds. Such accidents do undoubtedly account for many special facts of distribution and acclimatisation—for example, all oceanic islands, as Mr. Wallace has amply shown, are peopled with mere waifs and strays of various distant faunas and floras in just this fragmentary fashion. But the case of the spurge is by no means a solitary one; on the contrary, the south-western districts of England and of Ireland are full of peculiar species found in no other parts of Britain. Thus a pretty little purple lobelia, a familiar plant in southern France and Spain, is alone found with us on a single common near Axminster in Devon. So, too, Cornwall and the Scilly Isles are rich in southern forms. The arbutus, or strawberry tree, which grows so abundantly, with its white bell-shaped blossoms and its pretty red berries, over the Provençal hills, is met again quite unexpectedly on the mountains of Kerry. The Mediterranean heath—that

beautiful white scented heather which every visitor to the Pyrenees has gathered in spring among the pine-woods of Pau and Arcachon—turns up once more a thousand miles off in Connemara. Altogether, no fewer than twelve Spanish species are found in south-western Ireland, and in no other part of Britain ; while similar species extend to Pembrokeshire, or are peculiar to the south-western peninsula of England and the Mediterranean or Spain and Portugal. A special Portuguese slug and a few other southern animals are also found under the same conditions.

Clearly it would be absurd to set down so many coincidences between these warm western regions of Britain and the Continent to the chapter of accidents alone. Our south-western flora is undoubtedly on the whole a Spanish and Pyrenean flora in its general aspect, with a large intermixture of northern forms. Sometimes the south European species linger on only in a single spot, like the hairy spurge at Claverton Down and the purple lobelia at Axminster ; sometimes they spread over wide areas, and hold their own manfully against the intrusive Scandinavian types. Of these curious phenomena the probable explanation is suggested in a passing hint by Mr. Wallace.

The southern plants are probably relics of the flora which lived in Britain before the glacial epoch. At that time, as our geologists are agreed in believing, Great Britain and Ireland formed part of the continent of Europe, to which they were united by a broad belt of land, extending over the present bed of the English Channel and the Bay of Biscay. As the ice pushed its way southward, the northern plants migrated before it

to regions which were made more fit for them by the change of climate due to the glaciating conditions. Thus the arbutus, the Mediterranean heath, the various warm types of saxifrages, of butterwort, and of spurge, must have had a range from Killarney and Cornwall to the Pyrenees, the Apennines, and Crete. It is noticeable, too, that according to the map recently published by Dr. Geikie, the south-west of Ireland and England are just the parts of Britain which escaped glaciation during the height of the great ice age.

Very possibly, however, these warmer plants may at first have been driven quite southward, beyond the existing limits of Britain, but may afterwards have moved northward again as the ice melted. When the connecting lands were washed away by the waves, or submerged by alterations of level, the arbutus, the lobelia, and the scented heath would be stranded, so to speak, in a few warm corners of England, Wales, or Ireland, and would be separated by many miles from all other specimens of their race elsewhere. In some cases, no doubt, they would be killed off by the intrusive Scandinavian forms, which always show a singular power of living down all opposition ; and as still warmer types would finally occupy the lowlands of southern France, when the ice age was quite over, it happens now that these insulated plants live in the mountain districts only—the Pyrenees, Auvergne, and the Mediterranean islands, as well as in the hill regions of Kerry and Cornwall. The warmth derived from the Gulf Stream and the insular position has put the west coasts of our islands on a practical equality with mountain-countries many degrees south of them. The same

climatic peculiarities which make the horse-chestnuts bud a month earlier in the valley below me than on the east coast have enabled the hairy spurges to live on for ages among the combes and dells of this broken oolitic down, in spite of their total separation from the main body of their congeners elsewhere. Warm nooks like Bath and Bournemouth, in fact, form as it were climatic islands in the midst of our average British temperature; while in the sheltered spots of the Isle of Wight the Italian arum and the woodland calamint live on as wild plants, whereas they have long since been totally extinguished by the cold in all the rest of England.

IV.

WILD HYACINTHS.

THE path through the Fore Acre leads right across Venlake by tortuous windings to the tangled covert and bosky marshland of Sedgewood Copse. There is something to my mind very sweet and melodious about these dear old-world English names. Most of them go back even beyond the Norman conquest. The Fore Acre, for example, is so called, not because it once contained four acres, as the labourers will tell you, but because it is the acre or field lying just in front of the old immemorial homestead. In early English acre simply means field ; its later use as a definite measure of area, instead of the hide, is a mere modern innovation. As a matter of fact, the size of any particular Fore Acre depends usually upon the purest chance—our own here is a very small croft indeed—and the Six Acres or Ten Acres of latter-day farms are simply the results of false analogy on the part of countrymen who have misinterpreted the good old English phraseology of their forefathers. For ten centuries, in all probability, the farmhouse and barton of Shapwick Farm, for the time being, have stood on the selfsame site that the modern

stone buildings now occupy ; and the ancient name of the Fore Acre sufficiently vouches for the fact.

So, too, in the word Venlake we have another curious old verbal relic : for lake in our country dialect hereabouts means brook or river. As to Sedgewood Copse, that clearly derives its name from its marshy nature : for all the lower part of the wood along the banks of Venlake is a deep morass of spongy bog, thickly and treacherously carpeted now in spring with an exquisite green pile of glossy liverworts, pondweed, and brooklime. But in the upper part, on the slope close by, great masses of wild hyacinths are out in blossom, dyeing the whole side of the copse a brilliant blue with their dainty drooping heads of clustered flowers. Blue-bells we call them here in the south ; but in the north that pretty name belongs rather to the hare-bell or heather-bell, which is the true blue-bell of Scotland and of northern poets, growing abundantly on all the bleak heather-clad hillsides of the Highlands. Few flowers more distinctly mark an epoch in the country calendar than these same tall and nodding English wild hyacinths.

They blossom early, do the hyacinths, because they have got a good stock of material in their bulb to go on upon. Grub one up with your stick from the soft black mould of the copse—they are not deeply buried, while the mould is anything but stiff—and you will see that the white bulb is large and well filled, especially in the younger budding specimens. Cut it in two with a jack-knife, and a clammy white juice exudes from its concentric layers, rich in starches and gums for the supply of the large thick-petalled flowers. These first spring blossoms are almost all bulbous ; otherwise they would

not be able to bloom so early in the year. Black Dog Mead is now all full of buttercups which a townsman would never know from the summer kind ; for the flowers are just the same, and townsmen seldom trouble their heads about stems, or roots, or foliage. But the countryman knows the two weeds apart right well, for one is a much more troublesome intruder in a meadow than the other. This early form is the bulbous buttercup, and it flowers first just because of its bulb. After it has withered and set its seed, the regular meadow buttercups begin to blossom, having had time to collect enough material for their flowers meanwhile. The leaves and root are quite different, and so is the calyx ; and these minor peculiarities are, no doubt, correlated in some curious way with the various needs of the two plants, though no one can yet tell us how.

It is just the same with the hyacinth. Its long blade-like leaves laid by materials for growth last summer, and stored them up in the bulb ; and that enables them now to steal a march upon the annuals or thriftless perennials, and to entice the spring insects long before their loitering rivals have got out of their buds. It is the early bell that catches the bee. Only, both flowers and insects need to follow one another in a fixed succession throughout the year, or else there would not be food and visitors for both. The bees, too, have their calendar. Their year begins with gorse and willow catkins ; goes on to primroses and hyacinths ; continues with mint, thyme, rampion, and heather ; and finishes up at last with hawkweed, hemp-nettle, and meadow-saffron. Where all the bulbs, roots, and tubers can find room in the ground, however, is a mystery ; for one and the same field will be thick

with flowers all the year round, from the celandines of spring, with their little clustered pill-like nodules, through the tuberous orchids and thick white-rooted dandelions of summer, to the bulbous squills and lady's-tresses of late autumn. When one thinks of them all packed away side by side in the interstices of the stones and grasses, one begins to understand what is meant by the struggle for life in the world of plants.

The wild hyacinth is very essentially a bee-flower, one of the kinds which have specially adapted themselves to that one peculiar mode of insect fertilisation. Its colour alone might give one a hint of its nature ; for blue is the special hue affected by bees, and developed for the most part by their selective agency. All the simplest and most primitive flowers are yellow ; those a little above them in the scale have usually become white ; those rather more evolved are generally red or pink ; and the highest grade of all, the blossoms peculiarly modified for bees and butterflies, are almost always blue or purple. Now, one cannot look closely at a wild hyacinth without perceiving that it has undergone a good deal of modification. It is, in fact, a very high type of its own class. It belongs to that great family of flowers whose parts were originally arranged in rows of threes : but this original arrangement it almost seems at first sight to have doubled. Count the parts, and you will find that it has now six blue petals, with six stamens, one stamen being gummed on, as it were, to each petal ; while in the middle there is a single unripe pale-blue seed-vessel. But in the primitive ancestor of all these trinary flowers—one-half of all flowering plants—there

were three calyx pieces, three petals, three outer stamens, three inner stamens, and three seed-vessels. How, then, are we to account for these divergences in the modern wild hyacinth?

Why, if one looks closely it does not require much imagination to see the threefold arrangement still in full force, very little masked by small modifications. A pocket-knife will often clear up a great many of these difficulties; and if the unripe seed-vessel of the wild hyacinth be cut in two, the section at once shows that it consists of three cells, united at their edges, and each full of seeds. As Mrs. Malaprop would say, it is really three distinct seed-vessels rolled into one. Such union of the carpels (as they are called technically) is always a common concomitant of high development, and goes together with improved means of fertilisation. In simpler allied forms, such as the water-plantain, the three carpels remain always distinct; but in the more advanced lily family, to which the wild hyacinth belongs, they have universally coalesced into a single three-celled capsule. In autumn, however, when the capsule is ripe, it splits into three parts to shed the little shiny black seeds, and then clearly manifests its original character.

Outside this triple fruit we get six stamens; but if you look close you can see that they are in two alternate rows of three each, one set being a good deal longer than the other. The stamens have grown almost into one piece with the blue petals; yet the inner set have coalesced less thoroughly than the outer, for you can pull the three shorter ones off, but not the three longer ones. Their coalescence is another device to ensure

more perfect fertilisation, and to make the pollen adhere more certainly to the visiting bees than in other flowers. Outside all we get the six blue petals, three of which are really calyx pieces, indistinguishable in colour and shape from the true petals, but recognisable as to their real nature by two signs—first, that they slightly overlap the others, and secondly that they have the long stamens of the outer row opposite to them and combined with them. In all the lilies the calyx pieces and petals are very much alike and similarly coloured ; but in the wild hyacinth the similarity is even closer than elsewhere. This is doubtless due to the shape of the flower, which, in order to accommodate its favourite bees, closely simulates a true tubular blossom, like the Canterbury bell. At first sight, indeed, one might almost take it for such a perfect tube ; but when you pull it to pieces, you see that the six apparent petals are really distinct, though they converge so as practically to form a bell-flower, with a tiny drop of honey glistening at its base. In the true hyacinths of our gardens the six pieces have actually coalesced into a solid and well-soldered tube, which marks a still higher level of adaptation to insect visits : and even our own wild species shows a slight tendency in the same direction, for its pieces are often very shortly united together at the bottom. It is from such small beginnings as this that selective agency slowly produces the greatest changes ; and perhaps after the lapse of many ages our own wild hyacinths may become really tubular too, under the modifying influence of insect selection. But at present the frequent recurrence of white varieties—a probable reversion to some earlier

type—proves that our native plant is still far from having completely adapted itself even to its present level of insect fertilisation. Thoroughly well-established and ancient species do not throw back so easily or so often to less-advanced ancestral forms.

V.

THE TROUT JUMP.

POOR little May-flies on the pools of Venlake, you have at best but a hard life of it! Though your wings are fairy-like and light as gauze, though the sunshine plays upon your dancing bodies with opalescent hues, though you spend your time merrily enough to all seeming in flitting and flirting by the cool rivulet, yet is your appointed span but twenty-four hours long, and even for that short space your courtship and your maternity is environed with manifold dangers and endless foes. You pass your days between the Scylla of sunshine and the Charybdis of cloudy skies. When the sun shone yesterday, you were devoured in the midst of your love-making by the gay swallows ; when the clouds cover the heaven to-day, I see the trout are leaping to engulf you as you try in vain to lay your eggs in peace and quiet on the calm surface of the water. The fish can see you quite enough against the background canopy of cloud, and there is nothing they love better for their morning meal than a good fat mother May-fly.

I wonder very much what thoughts pass through the heads of these jumping trout as they gaze up eagerly towards the vast white sheet above them, just dappled

here and there by the little spot of darkness that forms to them the visible symbol of an eatable insect. One of the great dangers, indeed, which surround the path of scientific psychology is that of being too exclusively human. Here more than anywhere else in science the old Greek doctrine that man is the measure of all things seems especially to beset us on every side. Our own consciousness being the only consciousness which we can experimentally examine, we are peculiarly liable to accept its component elements as being the component elements of all other consciousness whatsoever. It is very hard—some philosophers have even told us it is impossible—to construct a comparative psychology, as we can construct a comparative osteology or a comparative philology. All the other minds about which we can obtain even the second-hand information given us by language are still human minds; and for the animal consciousness generally we are reduced to very inferential and doubtful data.

Yet even here a good deal can be done by careful sifting of facts, if only we know what facts to sift. The general principle of *nihil est in intellectu* stands us in good stead when once we have been able to discover what was before *in sensu*; and this we can often do provided we take the trouble to follow out all the hints supplied us by the nervous system and by the habits or peculiarities of animals. In some fishes, for instance, there is every indication of the preponderance of smell over sight as an intellectual and guiding sense. In the sharks and rays the membrane of the nose is enormously developed; the olfactory nerve is by far the largest and most important in the body; the central organs directly

or indirectly connected with it form the main mass of the brain ; and the indications of habit, as well as the sniffing-muscles attached to the nostrils, all go to show that smell is really the chief sense-endowment of these predatory species. On the other hand, their eyes are relatively small and poorly developed, their optic nerves and lobes are unimportant, and the general indications (about which it is only possible here to speak negatively) do not lead one to suppose that sight is a sense of much practical value to the sharks and rays. There are other classes of fish, however, in which sight seems to play a far more important part, and here it is perhaps possible to institute some rough comparison as to relative perfection with the case of the human eye and brain.

The class of fish in which the eye is apparently best developed is that of the teleosteans, to which belong the perch, salmon, cod, sole, turbot, and generally speaking almost all the best-known and edible species, including the trout of Venlake. These fish are comparatively late arrivals in our oceans and rivers, when we judge by a geological standard ; but they have rapidly lived down the great ganoids which preceded them, and have reduced the shark family and the lampreys to a few predatory or parasitic species. Externally and structurally they differ in many particulars from all the other classes of fish, which are now represented only by a relatively small number of survivors ; but on the psychological side they differ most conspicuously in this particular—that, while the remaining ganoids, sharks, and lampreys all show signs of depending mainly upon smell, their modern superseders show signs of depending mainly upon sight. The eye of these fishes is large and fairly

developed ; the optic nerves are big, and arranged in the same manner as among the higher animals ; and the optic centres form by far the largest portion of the brain. On the other hand, the olfactory nerves and centres are small and shrivelled. The indications of habit are certainly rather inferential, yet they all point in the same direction as these structural facts.

Most common fish certainly find their food mainly by means of sight. The careful way in which it is necessary to imitate flies in order to deceive the wary trout shows that they can pretty accurately distinguish forms and colours. The rapidity and certainty with which other fish will rise to an artificial minnow on a trolling-line sufficiently proves the rapidity of their perceptions. The imitative devices or mimicry which exist among many species similarly prove how sharp are the eyes of their enemies ; for these resemblances can only have been developed in order to deceive the senses of other fishes, and would not, of course, go beyond the point at which they proved useful to the species. All flatfish closely imitate the colours and arrangement of the sand or pebbles on which they lie : and it is often difficult even for a human eye to detect a sole or a flounder in an aquarium, although one may be perfectly sure that it is to be found at the bottom of a particular tank. Some of them have special pigment cells, like those of the chameleon, which they squeeze out in varying proportions till they exactly resemble their surroundings ; and as this action ceases when the fish is blind, it shows that the protected fish themselves, as well as their enemies, are conscious of minute differences in form and colour. All the animals which inhabit the sargasso weed are also

coloured exactly like it, and so closely imitate it in many ways that I have often narrowly examined a piece of the weed freshly brought up in a bucket, and yet failed to detect any sign of life till I lifted the spray from the water and so compelled the hide-aways to reveal themselves. There is one pipe-fish, indeed, from the Australian coasts, which so exactly mimics the fucus in which it lurks that nobody would believe it is a fish rather than a branch of the weed round which it curls, until he has dissected it. The necessity for such close resemblances is the best possible proof of acute sight in fishes exactly analogous to our own.

That this faculty of vision includes a perception of colour as well as form is shown by the same facts ; but there are other facts which seem to indicate it yet more clearly. The teleosteans, which possess these developed eyes and optic centres, are the only fish in which Mr. Darwin has noted the occurrence of ornamental colours or appendages, due, as he believes, to selective preferences on the part of the animals themselves. It is curious, too, that all the indirect proofs of colour-sense in fishes occur among this same group. The ornamental colours generally coexist with very excitable tempers, as is also the case with such higher animals as the mandrill, the peacock, and the humming-birds ; and in the little fighting-fish kept as pets by the Siamese, the brilliant hues are only displayed on the appearance of a rival or of the fish's own reflection in a mirror. The moment the little creature sees another of his own kind, he exhibits all his colouring, and rushes against his enemy covered with metallic tints, and waving his projected gills like the wattles of a turkey-cock. Almost all the

most beautifully coloured fish are coral-feeders, dwelling among the reefs and feeding off the bright polypes and other beautiful creatures which abound in tropical seas.

This case is again quite paralleled by that of birds and insects ; for the most gaily coloured species, like the butterflies, rose-beetles, humming-birds, parrots, loris, and toucans, are flower-feeders or fruit-eaters ; and we may well suppose that in every case a taste for colour has been aroused in the creatures themselves during their constant intercourse with brilliant surroundings and their continual quest for brilliant kinds of food. There seems to be, in fact, a regular gradation of colour-sense and colour-beauty in fishes, the most highly perceptive being themselves apparently the most ornamented. There is also a similar gradation of general sight-faculties : from the case of a tropical shore-fish which can thrust its moveable eyes out of their sockets, and which hunts crustaceans out of water on mud-flats at ebb tide, or of an open-sea fish which swims half above the surface, and has its eyes divided horizontally into two portions, one adapted for vision in air and the other in water — to the blind fishes of the Mammoth Cave and of the marine abysses revealed to us by the explorers in the *Challenger*. From all these converging indications it is perhaps possible to make a nearer guess at the visual faculties of fishes than most people would be at first sight inclined to suspect.

VI.

CATKINS AND ALMOND-BLOSSOM.

In spite of the renewal of winter weather, the trees and flowers are still pushing on amain. Snow has fallen again, but there has been a time of sunshine since ; and though the air is keen, the leaves and bursting buds seem to be drinking in the sunlight at all their pores. Animals have felt the brusque change more than plants. A blackbird's nest had already two eggs in it a week ago ; but I fear the after frosts destroyed them. The early lambs look woe-begone as they straggle aimlessly across the damp fields, too cold to lie down and too tired to keep themselves warm by frisking about ; and many of the younger ones will suffer sorely. Farmers say, in their matter-of-fact way, that the lambing will turn out a failure ; and what a world of misery to the poor beasts themselves those hard business words cover with their cold phraseology. On the other hand, the plants and trees for the most part seem none the worse for the change. The wind has cut off the crocuses in a body ; but the lilacs are unfolding their leaves faster than ever, the hedges are green in a mass on sheltered southern aspects, and the flowering almonds have their naked boughs covered with clustering branches of delicate

pinky-white blossom, standing out in true Japanesque relief against the bold background of the deep-blue sky.

They are hardly pretty, these flowering almonds and other masses of spring bloom on leafless trees ; they sadly lack the natural accompaniment of green foliage, to which our eyes are so accustomed that the two together form for us what Mr. Whistler would doubtless call a native symphony in pink and green. Each individual blossom is beautiful in itself—I mean in the graceful and undistorted single almond ; for the double-flowering monstrosity, with its simple natural symmetry lost in a bunchy rosette of indistinguishable tags, is unlovely to the botanical eye. Each single five-petalled blossom is beautiful in itself, I say ; and even a tall spray of them deftly displayed in a vase against a contrasting background is effective enough, as those same cunning Japanese artists long ago found out, with their usual quick eye for colour-harmonies ; but on the tree, growing all together, they have a certain bare and poverty-stricken appearance as they cling tightly to their naked stems, which always suggests the notion that they are pitiably cold and want a few leaves to keep them warm. So, bright and spring-like as they are, they cannot be considered exactly pretty—at least from a little distance, or unless one stands close beneath the branches so as to isolate a few sprays in bold relief against the retiring sky.

This habit, in which so many spring plants and trees indulge—the habit of sending up their flower-stalks or opening their blossom before they put out any of their leaves—is a curious and interesting one. It is, indeed, far more common than casual observers would

be inclined to imagine: for the majority of spring-flowering trees have their blossoms in those large yet inconspicuous masses which we call catkins; while others, like the elms, have them in dense clusters, so closely seated on the boughs that comparatively few passers-by notice them. Almost all our larger native trees are catkin-bearers—oaks, alders, birches, hazel, beech, sallow, osier, poplar, and aspen; but only a few of them have catkins which attract much attention, the silvery white knobs of the willow family and a few others being the only ones which most people pick in spring among the woods. None of our own English trees has such a brilliant spring blossom as the flowering-almond, but among southern plants similar masses of early bloom are not uncommon.

In every case the reason for the flower preceding the leaves seems to be the same. It is in principle a chapter of natural economy, and it illustrates very well the way in which all nature is necessarily compelled to piece in with itself in every part. The catkin-bearing plants are chiefly, if not always, wind-fertilised; and they have their stamens on one tree and their pistils on another, thus ensuring the highest possible degree of cross-fertilisation. They produce enormous quantities of pollen, which they require, owing to the distance that often intervenes between one tree and another, and the wasteful nature of the wind as a carrier; and this pollen falls from them as a copious yellow powder when they are placed in a vase on a table, while it can be shaken in great quantities from the trees themselves. If the catkins did not come out till the branches were all covered with foliage, their chance of fertilisation would

be very slight; for the leaves would interfere with the passage of the pollen. But by coming out in early spring, before the foliage has begun to burst its buds, and when the winds are strongest, the catkins stand the best possible chance of fulfilling their special functions. A March nor'-easter whistling through the naked boughs is almost sure to carry a grain or two at least of the golden dust from one tree to the other, and so enable the alders, beeches, and hornbeams to set their seed in safety.

With the crocuses and almonds the case is somewhat different, yet alike in ultimate principle. These are insect-fertilised flowers, and by flowering so early they catch the bees in the beginning of spring. For, on the one hand, the bees must have a succession of blossoms all the year round (except in mid-winter), or they could never get on at all; and the very existence of insect-fertilised flowers as a body depends upon a tacit agreement between them—so to speak—not to interfere with one another, but to keep a continual supply for the bees and butterflies from month to month: while, on the other hand, the flowers themselves need each a time when they can depend upon receiving their fair share in the attentions of the insects or else they might never set their seeds at all. Some few of these early blossoms, like crocuses and primroses, have leaves which can stand the frosts of March; but others, like the elm and the almond, have more delicate foliage, which consequently comes out much later in the season. All these spring-flowering plants lay by material somehow or other the summer before for their next year's blossoms. The primrose has its store of food-stuff in its thick and fleshy

root stock; the crocus and the autumn-saffron in their bulbs; the catkin-bearing trees, the elm and the almond, in their inner bark and woody tissues. Trees, indeed, have an immense advantage in their huge perennial trunks; for, before the foliage falls in autumn, they withdraw all the useful material from the dying leaves, storing it away in their permanent tissues; and so almost all of them are enabled to flower vigorously in spring before any other plants, except the hoarders which possess bulbs, have been able to anticipate them.

VII.

SPRING FLOWERS.

WALKING down the avenue the other day, I noticed how the elms that line its sides and the flowering almonds dotted about on the shrubbery were all in full bloom long before the ordinary small plants could venture to peep out; and I could not help observing that this habit of early blossoming was closely dependent upon the great size and perennial trunks of the larger trees. They are enabled by means of their old wood to store up in their permanent tissues the organised material necessary for the production of flowers; and so they get a good start of all their less fortunate neighbours, and come in for the first attentions of the spring bees and butterflies. To-day, however, out in the deep lane which runs through Walcombe Vale, the similar efforts of the smaller plants are forced upon my notice. There are already some half-dozen flowers to be seen on the high bank that bounds the lane or in the meadows on either side; and every one of these flowers has some special device of its own which enables it to come out thus early in the season, before many of its near allies have begun to sprout from the swelling seed. It is a general characteristic of all the first spring blossoms that they appear

either before their leaves, or else while the leaves are still only half developed ; and of course such a habit implies that material for their growth has already been laid by elsewhere. For flowers are mere expenders of food, not accumulators of food on their own account. The leaves are the only part of the plant which can build up fresh organised matter ; and the matter composing every flower has been sent to it by the leaves, either immediately, as in most annuals, or through the storehouse of a root, stem, or tuber, as in most perennials. A hyacinth-bulb is a good and familiar instance of such a storehouse.

Here, for example, among the shady greenery of the bank I can gather numberless flowering heads of the perennial mercury—a queer little three-cornered green flower, with copious clusters of its tiny feathery blossoms hanging out upon long and graceful stalklets. This mercury has a permanent creeping root-stock, in which it lays by during the summer and autumn the material needed for its next year's bloom ; and so it can come out abundantly in the early spring before the shiny green leaves are yet fully opened. On the other hand, its very close ally, the annual mercury, grows afresh from the seed every season, and therefore it has not accumulated enough capital to begin flowering until the late summer and autumn months. Yonder, again, on the slope of the hill in the Fore-Acre, I see a pale bunch of primroses, their short stalks all tightly clinging to the root-stock, in which the material for their growth has been kept safely through the dangers of winter : and if you tear up the stock, you will see that it is large and starchy, though it does not actually form a tuber, as in its near and more brilliant relative, the cyclamen. Further on,

the railway embankment is all yellow with the tall gaunt-looking scapes and tufted flower-heads of the coltsfoot, a yet more significant and interesting plant. The coltsfoot is a sort of fluffy ragwort, which sends up from its perennial starchy root a number of solitary, stiff, straight, cottony stems at the first promise of spring, each ending in a single golden head, but without any foliage except some small brownish scales, much like those of sprouting asparagus shoots. After the blossoms are all over, the large woolly leaves begin to appear, and occupy themselves during the summer in collecting starch over again to fill the root for next spring's flower-heads. At my feet, once more, I see a mass of bright glossy heart-shaped leaves, interspersed with the brilliant yellow blossoms of the smaller celandine—'gilt-cups' the village children call them: and the celandine also enforces the same principle. It is one of the earliest flowers to appear in spring; while most of its congeners, the crowfoots and buttercups, do not show themselves till July or August: and if you grub it up you will soon see the reason why. The buttercups have simple thread-like roots; but the lesser celadine has a lot of roundish mealy tubes, which it renews from year to year, and which form the reserve-fund on which it draws for its early blossoms. These habits of storing starchy food-stuffs are to certain plants just what the analogous habits of laying by honey, hoarding nuts, or gathering grain are to the bee, the squirrel, and the harvesting ants, among animals.

Turning from these little wayside blossoms to the large and conspicuous spring flowers, such as the daffodil, the narcissus, the snowdrop, the hyacinth, and the crocus,

one cannot help observing at once that they are all without exception bulbous plants. Their large showy heads of bloom require far more expenditure of raw material than the tiny green flowers of the mercury, the thin pellucid rays of the primrose, or even the bright golden corolla of the lesser celandine. Moreover, if you look closely at most of these bulbous blossoms, you will see that they have very thick and fleshy petals, quite different from the light papery petals of the wood anemone or the violet. This fleshiness is very well exemplified in the hyacinth, the tulip, and the tiger-lily—all of them thick and stout blossoms, which flaunt their colours boldly in the sunlight, and are little afraid of either wind or rain. Throughout the whole of nature, I believe, you will never find a brilliant mass of heavy bloom on a strictly annual plant; and all the more massive forms are provided for beforehand by means of bulbs, corms, or tubers. Such are the water-lilies, lotus, dahlias, orchids, iris, gladiolus, tuberose, arum, amaryllis, fritillary, saffron, tulip, and almost all lilies. On the other hand, whenever you find a single comparatively inconspicuous plant among these families—as, for example, Solomon's seal, with its small drooping greenish-white blossoms—one is sure to find also that it is a bulbless annual.

Nearly all the other very conspicuous flowers are shrubby or arboreal in habit, and so get their working capital from the store laid up in the stem by last year's leaves: as in the case of the cherry, apple, hawthorn, pyrus japonica, lilac, rose, laburnum, and all the great tropical flowering trees. None of these ever flower until after many years of foliage; and if the flower-buds are

nipped off when the trees are young and first begin to bud, more food-stuffs are laid by to produce finer heads of bloom in later years. In the case of these alders here (which, however, being wind-fertilised, need make no special display), we can actually see where the catkins come from : for they were formed last autumn, and have hung on the trees unopened through the whole winter, so as to catch the very first chance of sunshine in the beginning of spring. So far as my observation goes, very few annuals or other unaided plants ever have conspicuous flowers ; and those few generally produce their blossoms late in the season, after the leaves have had plenty of time to make preparations for feeding them. Even these rare exceptions are very deceptive and papery flowers, like the poppies or the hand-to-mouth convolvuluses, which manage to make a great deal of show at very little real expense. They spend all they have on a little gaudy colour, thinly spread over an extremely large flat surface.

VIII.

RHUBARB SPROUTS.

THE beds of the kitchen garden at the present moment unintentionally afford an admirable illustration of the main principle upon which most natural colouring seems to depend. In their really beautiful display of bright and gracefully graduated tints they supply us with a picture which, but for its familiar utilitarian character, everybody would stop to observe and admire. There are long sticks of rhubarb, ruddy crimson below, and merging through delicate gradations of pink and white into the golden yellow of the cramped and etiolated leaves above. There is sea-kale, blanched in the stem, and unfolding at the blade into crinkled shoots of an indescribable but very dainty pale mauve or violet. There are beet-roots, sprouting with dark Tyrian-red leaves, whose purplish veins persist even in the greening later foliage. Almost every one of the spring plants has more or less of these bright hues, marking them off at once from the common green of full-blown summer leaves. Even on the asparagus one may observe a set of little bluish scales; while the young tufts upon the carrots are pale yellow or golden brown. The reason throughout is a very simple one: all these spring vegetables are

perennials grown from a permanent root-stock; and in some cases they have been more or less blanched, naturally or artificially, by growing underneath a loose mass of heaped-up earth. If one looks into the flower-garden, one sees the same thing in the sprouting pæonies, whose rich red foliage is more likely, perhaps, to be admired than the very similar leaves of the beet. All these brilliant colours on spring plants are interesting because of the light which they incidentally cast upon the origin of the equally brilliant and far more definite colours of fruits and flowers.

Those who watch trees and bushes closely must have noticed that the first buds in spring are usually more or less red, or at least reddish or brownish. They must also have noticed that in summer the ends of long growing sprays are likewise ruddy, or purple, or warm brown. Now, at first sight, these facts do not seem to have much connection with another class of facts, such as those noticed above, of which we may take as a typical example the delicate blue or violet tinge on potato-stems allowed to grow in a dark cellar. But when we come to look at them closely, it is clear that they have all one characteristic in common: they are leaves or leaf-stems which are not performing their proper functions. All plants, of whatever sort, when placed in full sunlight develop the active green colouring matter in their leaves—the chlorophyll which enables them to analyse carbonic acid in the air, and to store its carbon as starch in their own sap or tissues. When they are kept in the dark, however, or when they are yet too young to have assumed their proper office, they do not contain any of the green colouring matter, and so they look yellow, pink,

or white. The bright hue thus assumed by young or etiolated leaves is due to the oxidation of their materials; and, in most cases where growth takes place from a stock of food already laid by, such oxidation must necessarily go on. It is thus that we get the brilliant red, blue, and yellow colouring of rhubarb, sea-kale, potato-sprouts, beetroot leaves, growing pæonies, or young carrots, as well as of long sprays in hedgerows and on young rose-bushes. As soon as the leaves are fully expanded, the green chlorophyll begins to develop, and they rapidly assume their true hue and their active life; but if they are kept in the dark, or prevented from normally developing, they go on retaining their original bright colours for an indefinite period.

It seems most probable that in all cases the oxidation of green leaves, stems, or other parts of plants, produces bright red, yellow, and orange colouring matter. We are all familiar with this fact in the instance of autumn hues, where Mr. Sorby has shown that the pigment is chemically nothing more than an oxidised form of the ordinary chlorophyll. So it is in the case of both flowers and fruits, which are purely expensive structures, produced for the most part from reservoirs of raw material, such as bulbs, tubers, starchy root-stocks, or permanent stems, and thus exactly resembling the red or purple shoots of the pæony, the rhubarb, the sea-kale, and the hawthorn bushes. Every one knows that fruits are at first green, and only grow coloured as they ripen—that is to say, as they oxidise. Mr. Sorby has shown that in flowers, too, the colouring matter is at first green, and exactly resembles that of ordinary leaves; but as they

grow older they also get oxidised, and so assume their bright hues.

In fact, the pigment of the petals in many cases is exactly the same, both in colour and in chemical composition, as that of the autumn leaves from which the chlorophyll has disappeared, or of the young spring foliage in which it has not yet been developed. So that, to put it simply, all plants, whether they produce brilliant fruits and flowers or otherwise, have in them all the material necessary for such a display, and could be induced to assume bright hues under proper circumstances, just as our gardeners have made the leaves of geraniums and many other plants do so since the taste for coloured foliage plants set in. Besides, such bright hues are especially apt to appear in the neighbourhood of the fruits or flowers, and do often appear there without any special reason. If, then, in the wild state, they ever happened to show themselves in such a manner as to benefit the plant by attracting birds or insects, we may be pretty sure that the tendency once set up would continue and increase from generation to generation. As a matter of fact, it is manifest that some familiar fruits and flowers only show the tendency even now in a very nascent or incipient form, while others show it in a highly developed degree. For example, in peaches and apples only the sunny side is coloured at all, and that in a very irregular and patchy manner; whereas oranges are fully coloured in every part. On the other hand, pears as a rule hardly show any signs of colouring beyond a slight browning of the peel on one side. Cherries give us every stage—from the merely pink-cheeked whitehearts, to the deep and uniform red of the

morella. So, too, among flowers, we may compare the almost accidental pinkiness of the rays in a daisy with the full rich purple of a cineraria. These intermediate cases help perhaps to show us how colour first begins to gather in some particular part, and so forms the groundwork upon which selective action may gradually be exerted. It is not difficult to see how the first few faint streaks of red may begin to dapple the cheek of a ripening fruit, just as they dapple the surface of autumn leaves; and yet when that step has once been taken, it is easy to fancy the subsequent stages by which the colour becomes intensified from year to year, through the constant preference shown by the animal allies of the species for the most conspicuous fruits. In the end, alike with berries and with blossoms, the colouring, which began by being accidental and indefinite, finishes by being perfectly definite and regular.

IX.

THE SWALLOWS AGAIN.

At last the long-wished-for rain has come in earnest; the ground has drunk in water enough to give it more than a mere surface wetting; and the grass and leaves begin to look themselves again after the long spell of dry and warping weather. We had a few slight showers last week, but they barely sufficed to lay the dust for a couple of hours; and as soon as they had dried up, the east wind blew it about once more, so that even the young green on the hedges and the horse-chestnuts was smothered in a loose coat of greyish grime. Now, however, nature comes out anew after the downpour in its freshest spring colours. The clouds still lower, and the tops of the downs are still lost in slowly shifting mists; so to-day the swallows have left the open meadows and are flitting low above the river, gaping open-mouthed at the water-flies and skimming the surface of the stream with their long blue-black wings. Leaning here on the rough parapet of the old stone bridge, I can see the flies at which they are darting just below me; for swallows are always fearless of man when on the wing, and do not hesitate to approach him flying; though they seem hardly ever to alight anywhere within an easy

stone's-throw when he is by, except of course in their nests. Their ceaseless motion and their curious independence of rest strikingly recall the little humming-birds whom I have often watched in like manner, whirring past me from flower to flower in tropical gardens; and, strange as it sounds to say so, the swallows and the humming-birds are indeed first cousins to one another, though so very different in outward shape and plumage. Indeed, nowhere else are appearances more deceitful. The humming-birds are not at all related to the sun-birds of India and Africa, which are so like them as to be colloquially called by their name; while they are closely related to the very unlike swallows, being, in fact, American swallows which have never taken to migrating very far north, and have accordingly adapted themselves instead to a continuous tropical or sub-tropical existence.

Prince Lucien Bonaparte was the first to show that the humming-birds were really most nearly allied to our dingy northern swifts. Of all the swallow family, the swifts are the most ceaselessly active and possess the widest relative stretch of wing. Though a full-grown bird usually weighs scarcely one ounce, it measures eighteen inches from tip to tip of the pinions. No one ever saw a swift perching on a tree or hopping about the ground: except when asleep, it is almost ceaselessly upon the wing. It catches its food flying; it drinks as it skims the surface of the water; it picks up the materials for its nest while sweeping among the meadows close to the ground. Now, if you transfer some of these active, restless, insect-catching swifts to the tropics, what will be the natural result? A large proportion of

tropical insects find their food in the large bells or deep tubes of the brilliant equatorial flowers. So the swifts would naturally take to flitting about in the neighbourhood of these blossoms and poising themselves on their powerful wings just in front of their corollas. Those of them which took permanently to such a mode of life would soon adapt their external structure to the new conditions with which they had grown familiar. Tropical swifts with the longest bills and the most extensile tongues would have an advantage over others, because they would best be able to probe the long tubes of the flowers and extract the insects from them, inside the nectary itself. In this way the bill and tongue have gradually grown so long in their descendants, the humming-birds, that all outer resemblance to the parental swallow form has been wholly lost; and the family was, accordingly, classed till quite recently with the externally similar, but genealogically quite distinct, group of sun-birds.

In most other respects, however, the humming-birds continue to resemble the ancestral swifts. The shape of the wing and its proportion to the body is exactly the same; but, above all, the numerous minute anatomical points of similarity settle the question at once for modern biology. Even before evolutionism gave the new key which solves so many of these difficult problems, it was noticed that the humming-birds were very like the swallows in many anatomical particulars, though very unlike them in plumage and in the shape of the bill. Dr. Jerdon, who has spent his life in studying the birds of India, hesitated about ranking the sun-birds by their side because of this structural community between

humming-birds and swallows; but he reassured himself when he looked at the general external likeness of the two tropical groups. Now, however, we have learned that such external likenesses are necessarily produced by community of habit and mode of life; while underlying structural resemblance forms the best test of genealogical relationship. Mr. Wallace has shown conclusively that the humming-birds are in reality modified swifts, and that their resemblance to the Oriental sun-birds is wholly due to the similarity of their circumstances.

In fact, the habits of the two races, though much alike in many respects, still bear evident traces of their original derivation. The sun-birds are by origin creepers; and, like other creepers, they have not very large or powerful wings, and their feet are formed for perching, which is not the case with either the swifts or the humming-birds. When a sun-bird wants to suck the honey of a flower, it does not hover in front of it, poised upon swiftly vibrating pinions, like its supposed American allies; but it perches first upon the stalk or branch, and then extracts the nectar at its ease. The humming-birds, on the other hand, being developed insect-eaters, never alight, but catch their food upon the wing, just as their ancestors the swifts were accustomed to do. Moreover, they are not to any great extent honey-suckers; what they seek in the nectary is not so much the honey as the insects which have come to eat it. These they can extract with their long tongues at a single flick, and then they dart away again, just like the swallows, in search of more. Mr. Wallace has shown that young humming-birds starve upon honey, but live

and thrive upon insects alone ; being, in fact, as he puts it, still in the swift stage of their development.

As for the points of convergence between the humming-birds and the sun-birds, those are easily enough explained. Both races feed upon long-tubed tropical flowers, probing their recesses in search either of honey or flies ; and both, consequently, require long bills and extensile tongues. Both races also possess brilliant plumage, with metallic crests or gorgets ; and such brilliance is common amongst all flower-feeding and fruit-eating species, such as butterflies, rose-beetles, toucans, parrots, and birds of paradise. The constant association with coloured objects, and the constant search for them as food, seems to arouse a taste for bright colour in the creatures themselves, which is actively exerted in the choice of mates. Why some members of the swift and swallow family should have undergone this change to humming-birds in the western continent and not in the eastern would be a more difficult question to answer offhand ; but I fancy the difference may be partly due to two causes. In the first place, the peculiar way in which the Old World is cut up into two distinct regions, hot and cold, by the Mediterranean and the Himalayan range may have favoured extensive migration here ; while in America the continuity of land, the warmth of summer, and the general luxuriance of blossoms permit humming-birds to range as far north as Canada ; and thus one continent may have favoured only the old open insect-hunting types like the swift, while the other favoured also specialised flower-haunting types like the humming-birds. In the second place, the creepers may already have occupied

the field in the small portion of Africa and Asia fitted for the evolution of such a race as the humming-birds, and may thus effectually have prevented the eastern swifts from ever developing in that direction. Of course in any case the specialisation of humming-birds in America must date back to a very remote period, both on account of the profound modifications their form has undergone, and on account of the immense number of genera and species into which they have split up.

X.

THE GREEN LEAF.

WHAT an exquisite green, deeply tinged with yellow, this young foliage of the oak shows us in these its earliest stages! The first flush of the hedges was spoilt for us this year, indeed, by the long mild weather of March; the hawthorn bushes came out too slowly and sporadically before their due season ever to display that living outburst of fresh verdure in which they revel when a week of bright sunshine comes in early April after protracted east winds, followed by a single quickening shower or so, to plim out and burst the swelling buds. But the larger trees are making up for it now: their leafing is favoured by just such an interchange of sun and shower as best suits their ingrained habits. The country people use them to prognosticate the weather, with scarcely more distinguished success than the Meteorological Office itself. 'When the oak's before the ash,' runs our rustic jingle, 'Then you may expect a splash; When the ash is before the oak, Then you may look out for a soak.' *A priori* considerations might thus easily induce one to conclude that in England the ash invariably preceded its great rival. But, as a matter of fact, here as so often elsewhere, practice seems to con-

tradict theory—the oak oftenest leads the way. Hence, considering the nature of our climate, the proverb usually turns out wrong ; which, of course, makes no difference at all in the faith reposed in it year after year by some thirty millions of people in this kingdom. *Instantia contradictoria non movet.* Once let a saw take deep root in the rural mind, and no experience will ever oust it. We have another local saying hereabouts, that 'Godshill plain Is a sign of rain.' Now, Godshill stands on the very verge of the horizon, and is only visible in very clear set-fair summer weather ; but week after week in fine summers every inhabitant of the village goes to bed nightly muttering to himself that it will rain to-morrow because Godshill is seen so distinctly this evening.

The yearly rejuvenescence of the trees in the fields around us, though habit has somewhat dulled our appreciation of its significance, is yet a very beautiful and a very suggestive phenomenon. Strictly speaking, according to the view adopted by our most philosophical biologists, the leaf, not the plant, is the real individual of the vegetable world : and the tree as a whole is in fact a great united colony of such separate individuals. One may compare it to a coral-branch covered by thousands of little living polypes, or to a sponge made up of myriads of tiny jelly-like beings. Each leaf sprouts, lives, and dies independently, without its death at all affecting the general life of the community to which it belongs ; and the seed that the tree as a whole sends forth to perpetuate its kind is not so much a new individual as the germ of a whole new colony. It resembles rather a swarm of bees going forth to found a new hive than a mere single young individual cast upon

the world on his own account. Yet the leaf differs from the coral polype in one important particular: its life is carried on in subordination to the life of the whole tree of which it forms a part. Sap and protoplasm are supplied to it from the older organs behind. It is like some member of a civilised community whose own separate functions are intimately bound up with those of all the others, on whom he depends variously for food and clothing; whereas the polype is like a mere hunting savage, self-supporting and comparatively isolated, though forming part of a rudely aggregated whole. And just as one individual in the community may die without endangering the existence of the community in its corporate capacity, so the separate leaves may fall away and die without endangering ı lessening the life of a tree on which they grew. In this way they differ materially from the organs of a single organism, no one of which can be cut away without seriously damaging the entire body of which it is a portion.

Metaphysical as this conception sounds at first hearing, it would still be hard to realise in any other fashion the actual life of trees. The green leaves which they are now putting forth so abundantly are each new members of the foliar commonwealth. They spring from buds, prepared for the purpose before last winter set in; and they are nurtured by the material drawn from the dead leaves of last year's crop; for that is how the corporate existence is kept up from season to season. What fell last autumn was not the living part of the leaves; it was merely the dead skeleton of the foliage—the mass of empty cells and stringy fibre, from which all truly vital matter had been carefully withdrawn. The active

protoplasm and green chlorophyll from each cell of the leaf moved slowly out with strange groping serpentine motions, like little shapeless jellybag animals, at the first approach of autumn frosts, and stored themselves up securely in the permanent tissues of the stem till the present time. How they have acquired the cunning to do so, under the influence of natural selection, is one of the greatest problems yet remaining unsolved in all the history of life; indeed, the more one looks at the apparently spontaneous and voluntary movements of this formless primary protoplasm, the more exactly do all its properties, even in a plant, seem to resemble those of conscious and intelligent beings. It is not merely that protoplasm feels its way and moves responsively to changes around it, but it also acts with every appearance of deliberate volition. All winter long these living principles of the dead leaves remain stored up within the trunk or branches; and now, when the sun returns to us again, they are pushed up anew into the bursting buds, and go to form the young leaves of the new year. The vital protoplasm divides itself once more into cell after cell in the fresh foliage; each little globule surrounds itself with a solid wall secreted from its own substance; and the whole mass burgeons forth apace into a new set of leaves.

Thus in one sense we might almost say that this year's leaves are last year's over again. Whatever was really vital in them remains; what was cast away was but the bare shell that surrounded the true living material. Trees, in fact, are plant communities which have learnt thus to keep up a common life apart from the life of the separate individuals which make them up. Their

stems differ from the stems of herbs only in the thickness of their cell-walls and the absence of living matter in the woody tissues. Accordingly, trees appear in the most widely different families of plants ; and sometimes they are closely related to very small and weedy types, as among the roses, which vary in stature from little creeping herbs like the wild strawberry to tall trunks like the pear-tree. Wide as the difference seems to us, it is but a slight one in reality : a tree is only a herb which has prospered best by growing stiff and perennial, and so has acquired the habit of making its stem very stout and hard, to resist the greater mechanical strains that will now be brought against it by wind and weather. In all essential points each tree still preserves all the main features of the family to which it happens to belong.

XI.

THE FLOWERING OF THE GRASSES.

THE big dry logs beside the path in Holme Bush Fields make a pleasant seat in wet weather ; though why the Squire has let them lie here so long it would be hard to say ; for they are fine solid trunks of good timber, and now they are beginning to rot on the under-side, and to put forth beautiful patches of bright orange fungus at the scars of the main branches. Around them, the grass is growing tall and luxuriant, as it always does beside fallen wood ; and most of the heads are now coming into their first bloom, with the little quivering and shivering stamens trembling like aspen leaves before the faintest breath of wind. These smooth, round cylindrical mops, soft and hairy like a fox's brush, are the meadow foxtails ; these slender waving panicles, much branched and subdivided, with a faint purplish blush upon their tiny flowers, are the common field-grass, the most ordinary element of all our English pastures ; these larger, broader, flatter, and more turgid heads, fiercely bearded, and standing out square to the breeze, are haulms of brome ; and these single stiff, lance-like spikes, with dark-brown scales between the florets, are sweet vernal grass, the plant that, a little later, imparts

its familiar and delicious perfume to new-mown hay. You can pick a dozen kinds without stirring as you sit on the logs here. There are people who only know all these infinite varieties that go to make up the greensward of England as grass. But they are not grass, they are grasses. In Britain alone we have no fewer than a hundred and one species, without counting some seventy sedges which nobody but a botanist would ever think of discriminating from them. They are all really as much unlike one another, when you come to look into them, as a wild strawberry is unlike a dog-rose; yet even countrymen and farmers make little distinction between them, and not more than a dozen or so have real popular English names—such as fescue, matweed, wild oats, cordgrass, darnel, and wagging bennets. A few are troublesome weeds, like couchgrass; a few others are valuable fodder, like timothy; and these have naturally acquired names from the cultivators who befriend or exterminate them; while a few more are striking enough to attract attention by their prettiness, like quakegrass, tares, or nard; and these have sometimes been quaintly and prettily dubbed with Bible names by village children. But by far the greater number are too inconspicuous ever to have reached the dignity of any nomenclature whatsoever till the systematists took them in hand and divided them all artificially into different genera and species. Even the larger groups number in Britain forty-two.

Grasses have very degenerate flowers, almost more so than those of any other known family of plants; and yet even here we can still dimly trace some vague picture of their earlier pedigree in their present degraded condition. It is a great mistake to suppose that evolution

is necessarily always upward. On the whole, there is continuous progress; but there is much retrogression, too, in particular cases. I take a head of meadow brome, and pull its panicle to pieces. It is made up of several little flowering branches, each covered with tiny green or brownish flowers. Why green? Because the grasses are wind-fertilised and so have no need to attract insects; on the contrary, they do everything in their power to keep them carefully away, for the flies would only eat the pollen without doing any good to the plant in return. Now let me take one little separate spikelet of flowers from the head, and dissect it more carefully. Outside come two empty pieces of chaff, mere bracts or scales, meant to protect the flowers from intrusive ants or other creeping insects. Then, within these protective shields come the real flowers, each consisting of two somewhat similar bits of chaff—glumes we call them—enclosing three waving stamens and a tiny embryo grain. Not much like a lily or wild hyacinth at first sight, and yet the selfsame plan is traceable all through them. The ancestors of the grasses started by being a sort of lilies, each with three calyx pieces, three petals, three stamens, and three cells to their fruit; what has become of all these parts in the meadow brome? Well, they are almost all there, if one looks close enough to see them.

First there is the calyx: that is represented by the two inner chaff-like glumes. Once upon a time there were three of these, and there are still rudiments of the three left; for the innermost of the two glumes is really a couple rolled into one, and has two little green midribs, one on each side, as you see, still marking the true facts as to its origin. In order to pack them away more

neatly on the branch, however, the one large outer calyx-piece overwraps the two small and united inner ones, so that to a casual glance they look like a pair of equal and opposite scales. That satisfactorily accounts for the calyx.

Next, how about the petals? Well, if you lift off the two glumes very carefully, you will see beneath them, just outside the stamens and the embryo grain, a couple of very tiny thin transparent leaves. They are almost microscopical in size, no bigger than the dot of an *i*, and so thin and filmy that they look very much like a midge's wing. So far as I can tell they are of no use at all to the plant as it now stands: they remain there as mere functionless rudiments, apparently on purpose to let us see the essential kinship between the grasses and the lilies. For these are two out of the three original petals, dwarfed almost beyond recognition, but still fairly to be identified by means of intermediate links. As to the third petal, which ought to be within, on the same side as the two calyx-pieces which are united into one, that has disappeared altogether, crushed wholly out of existence between the grain and the calyx. The fact is, the one-sided arrangement of the little flowers on the spike, necessary in order to let their stamens hang out freely to the wind, has distorted all the inner half of the blossoms—much as the habit of lying on one side has distorted and blanched the lower half of the sole or the flounder. But we have numerous intermediate forms still existing which lead us from the true lilies, with their coloured petals, through the wood-rushes, whose petals are thin and brownish, to certain sedges in which they have become mere rudiments, and to the grasses in

which only two of them can be distinguished at all. However, one group of very large and tall grasses, the bamboo tribe, still keeps all three of its petals; it is the smallness of our English kinds which has made the third and innermost disappear. The stamens are still all right; they keep up their original number of three; while in the fruit two of the cells have become abortive, for a reason which we will presently consider, and only one remains to produce a little corn-like grain. Our spike of meadow-brome contains several dozen such very tiny and degenerate lily blossoms.

But if the grasses are so degraded, why do they succeed in life so well? One has only to cast an eye at the fields around one to see that they have fared not badly in the struggle for existence. In the first place we must remember that in a natural state there are not, as a rule, nearly so many grasses as we see about us in England. Virgin forest would naturally cover much of the land which we have given over to meadow and pasture for our own purposes; and even where great prairies occupy many miles together, they are by no means so exclusively grassy as most people who have not seen them are apt to imagine. Setting this aside, however, it must be allowed that the grasses are really a very successful family, one of the most successful on earth. But the truth is, they owe their success to their very degeneracy. The most highly developed types of plants or animals are never by any means the most numerous. There are more acorn barnacles on a single mile of tide-covered rock than there are human beings in all the British isles. Who can count the number of little green aphides on a solitary rose-leaf, or the number of mites in a single

pound of old cheese? Yet all three classes are degenerate. It is just the same with plants: the small, lithe, waving grasses can fill up a thousand nooks and corners in nature which cannot be filled by the great oaks, or even by the tall docks, or spurges, or nettles. As a rule, one may say that the higher plants are comparatively few and far between, while the small, degenerate types are common and ubiquitous: just as one can everywhere find little insects and creeping things, while deer, elephants, zebras, and monkeys, both from their larger size and higher specialisation, are only found in small numbers over restricted areas.

But in their own way, to fill their own place in nature, the grasses, though degenerate, are admirably adapted to their particular station. The great secrets of their success are probably three in number. First, they have a general shape which allows them admirably to fill up all the cricks and corners between other plants—to economise any bit of waste space which no other competitor has seized upon; and in perfectly wild or tangled countries, this is really their main function in the complex balance of vegetable life. Secondly, they have an immense number of flowers stowed away in the smallest possible space, and fertilised in a very cheap and simple manner by the wind. And thirdly, they have learned to produce only one seed from each flower, in the shape of a single grain, more richly stored with food-stuffs for the young plant than those of almost any other species. One rich seed is worth more in the struggle for life than twenty poor ones. It is this last peculiarity that makes the grasses so largely cultivated by man. What feeds young plants will feed animals

also. We grow wheat, barley, oats, rye, Indian corn, rice, and millet for our own use ; and we grow almost all other kinds of grasses for our cattle and horses. Of course, everybody knows that hay is cut just when these rich seeds are at their prime, and it is comparatively valueless if allowed to grow over-ripe so that the grain falls out on to the ground below. Besides these main points, however, grasses as a group have a hundred minor adaptations, which give them special advantages in the race for the possession of the earth ; and, as to each particular grass, it has so many little tricks and devices of its own, that if I were to try to tell you all about the hairs and awns and bristles on this single bit of brome or of foxtail, we might sit here talking all the afternoon, and even then not have finished.

XII.

THE SUBMERGED FOREST.

LAST night's storm, coinciding with the spring tides, has laid bare the beach for a considerable distance; and this morning, now that the ebb is at its lowest, the stumps and twigs of the sunken forest may be clearly seen protruding from the underlying clay bank. All round the coast of England, wherever the land shelves slowly off to seaward, we may find a curious belt of such drowned woodland, partly uncovered at low tides, and generally filled with broken stumps and trunks of water-logged trees. These submerged forests are usually well known locally by that very name: but hardly enough attention has yet been given to the practical universality of their occurrence in all situations except where the presence of high cliffs clearly indicates that the land-line is being largely and rapidly undermined by the encroaching sea. Such broken stumps and logs are to be found, not here and there, but everywhere. They begin under the level flats of Morecambe Bay and the sands of Dee; they crop up again in the great bight of Cardigan Bay, where legend still commemorates the flooding of the Lowland Hundred which once occupied the space between the rocky barrier of Sarn Badrig

(or St. Patrick's Causeway) and the Merioneth coast; they are found once more along the entire line of the Bristol Channel; they fill up the hollows of Falmouth Harbour, of Torbay, and of Dartmouth; they recur here at the embouchure of Venlake; they extend along the whole Sussex shore; and even on the east side of England they have been traced in the estuary of the Thames, at Cromer in Norfolk, in the Wash, and near the mouth of the Humber.

In fact, the evidence goes to show that at no very remote period the land of England stretched further out to sea in every direction than it does at the present day. That most lively and amusing of mediæval writers, Giraldus Cambrensis—whose entertaining travels would, I am sure, be much more read if his name did not suggest incongruous notions of dry monastic chroniclers—has given us a full and really scientific account of one such submerged wood which he came across in South Wales; and ever since his time notices of these submarine remains have frequently been published. Yet no general explanation of their occurrence had been attempted till within the last few years. Even now, only a small number of scientific men have thoroughly realised the wide range of the facts to be explained in the case of the English coast.

The date of the submerged forests is, geologically speaking, quite modern. The stumps are still woody in texture, showing a bright pink hue when cut; and they would sometimes make very good timber if the softened outer layer were once scraped off. Twigs, nuts, and even leaves are often found almost unaltered in the brown clay which surrounds the stumps. In the Bristol

Channel, which was long a broad open valley, like that of the Thames or the Humber in our own time, caves are still to be found in the cliffs which once overlooked the wide plains ; and in these caves are numerous unfossilised bones of recent animals, devoured there by bears and hyænas. In one such cave no fewer than a thousand antlers of the reindeer were discovered. Such facts can only be explained on the supposition that the deer and oxen once roamed in the open valley beneath, and were preyed on by the carnivores which haunted the caverns. Every indication of the animals, the trees, and the position of the deposits goes to show that this age of forests extending far to seaward of the present coast was subsequent to the date of the last glacial epoch, and just preceded the final severance of England from the Continent. In all probability the ancestors of the South Welsh and of the small dark Celts of Scotland and Ireland were already settled in Britain before that severance took place.

The forest beds now stretch to a depth of some forty or even sixty feet below the present highest tidal level. Accordingly, the subsidence of the land appears to have been at least as much as sixty feet, and perhaps far more : for the trees must, of course, have flourished on the level of high-water mark, and possibly a good deal above it. Moreover, shore forms of shell-fish are found by dredging in similar old beds of recent but not of modern date at considerable depths below the surface, thus also showing a comparatively late subsidence of the land. As these phenomena are not isolated, but occur all round the coast of England, they probably mark a general lowering of the land surface, rather than a mere

series of disconnected local changes. There are many good reasons for supposing that England was still united to the mainland of Europe after the ice of the last glacial period had all melted away: because our fauna and flora are hardly at all peculiar, as is the case with islands long separated from the neighbouring continents. The animals and plants of Britain are the animals and plants of Europe generally since the glacial epoch; and they do not include any of those which are peculiar to the pre-glacial age. They are so numerous in species, and so fairly represent the fauna and flora of the Continent, that they must have entered Britain from the mainland by a broad ridge or isthmus at a period subsequent to the great ice age; and there is every reason to believe that the earliest race of men now inhabiting the island also entered it at the same period.

Had not such a bridge existed later than the time when the old fauna was killed off by the ice just as thoroughly as the temperate fauna of Greenland is killed off in our own time, it would be impossible to account for the presence of so many Continental animals, large and small, as we actually find in Britain. A few deer and a few rats might have swum over: but that all our shrews, foxes, badgers, hedgehogs, hares, rabbits, moles, squirrels, weasels, stoats, martens, field-mice, lizards, snakes, and other mammals or reptiles, could have come across by mere accident is incredible. Still less can we believe that our 120 species of snails and our numerous insects were introduced in such a fortuitous way. The straits which divide the Australian from the Javan and Indian fauna are scarcely wider than the strait which separates England from the Continent: yet not one

Indian species of mammal has ever found its way into Australia, nor one Australian species into the Javan and Indian region. There can be little doubt, therefore, that these submerged forests, almost modern in their appearance and overlying the glacial gravels, are relics of the land surface which once connected us with the Continent on the one hand and with Ireland on the other. If it be asked why, with such a wide connection existing at so late a date, we should lack so many Continental mammals, the answer is that in a small and thickly peopled area like England many of them have been exterminated, directly or indirectly, through man's agency, within the historical period. The bear, the wild boar, the wolf, the reindeer, and the beaver have all become extinct since the Roman occupation; the badger, the otter, the marten, and the stoat are being slowly driven out in our own time; the fallow deer and the white cattle have been artificially preserved; and even the fox would perhaps have died out long ago but for the strenuous exertions of sportsmen.

XIII

A SUMMER TRIP.

How many Englishmen, I wonder, at a competitive examination, could tell one anything definite about Lundy Island, whither we have come over to-day, like Mrs. John Gilpin 'on pleasure bent,' with our baskets and our bottles duly packed to enjoy a day's outing. A boat from Clovelly has brought us across gaily enough (in calm weather): and here we are, safe and sound, prepared to explore the zoological and botanical peculiarities of rugged little Lundy. There is an old story of a Scotch minister in one of the little islets of the Clyde mouth who once prayed for the welfare of Great Cumbrae and Little Cumbrae, and the adjacent islands of Great Britain and Ireland. The good man's simple insularity recalls to one's mind a certain wider insularity which we all of us share. When most people speak of the British Isles they probably have in their mind's eye only the two main elements of Great Britain and Ireland, without considering the 'adjacent islands' at all: and even if they thought a little upon the subject they would not be likely to reckon up more than some dozen others of the largest sort—such as Wight, Man, Anglesey, Orkney, Shetland, Skye, and Jura. But a geographical

authority credibly informs us that the British Isles really comprise no fewer than one thousand separate islands and islets, without counting mere jutting rocks or isolated pinnacles. Of these, perhaps some two dozen are situated in the Bristol Channel, mostly off the jagged South Welsh coast ; while three of them—the Steep Holm, the Flat Holm, and Lundy Island—may pretty fairly be considered as belonging to the real English shore.

Their very names are interesting, for the Holms were so called by the Scandinavian pirates and still retain the old Norse word for an island, which we meet again, for instance, in Stockholm, the isle at the debouchure of the Malær Lake ; while Lundy shares the common termination of most other eyots round the English coast—as in Sheppey, Walney, Anglesey, Scilly, and Caldy. The syllable in question is the original English form of the word island, which ought etymologically to be written 'iland'; and therefore Lundy ought to stand by itself, as Sheppey and Anglesey always do, without having a redundant and additional notification of its insularity tacked on without rhyme or reason to its name. But use and wont govern all these things : and just as people who are ignorant of the good old word 'mere' have taken to talking pleonastically of Windermere Lake, so all of us have taken to talking pleonastically of Lundy Island. It is only in the bigger cases of Sheppey, Jersey, and Anglesey that we still keep to the correct usage ; much as we always properly say Westmoreland and Cumberland without any 'shire,' as we ought to do, while the people of Rutland are often scandalised at hearing their little county wrongfully described as Rutlandshire.

Lundy is a small boss of granite with a little of the red Devonian rock in patches on its surface, rising somewhat abruptly from the bed of the Bristol Channel, only twelve miles from the steep promontory of Hartland Point. It is not more than three miles long, and it is little visited except by a few stray travellers from Clovelly or Ilfracombe, who go over out of curiosity, in order to say they have been to a place which hardly anybody else has been to before. But from the point of view of the geologist and naturalist Lundy and the Holms are full of interest. For if, as seems probable, the Bristol Channel was at no very remote period a broad and open plain, like that of the Gironde, through which the Severn made its way into the Atlantic somewhere off the south coast of Ireland, then these three petty islands are solitary remains of the submerged lands—little hills which have survived the general subsidence, as Glastonbury Tor might survive if the water were to break over the Somersetshire marshes, or as Primrose Hill might survive if the valley of the Thames were to sink some fifty feet below the sea.

We know that the warmth and the sea air have kept a great many south European plants and animals alive in the south-western peninsulas of England and Ireland long after they have been killed out in the colder regions of the north and east; and in these little islets of the south-west coast the insular conditions of heat, equable temperature, and moisture prevail in the highest degree. Everybody has heard of the sub-tropical vegetation of palms and aloes, which flourishes in the open air at Tresco Abbey, in the Scilly Isles; and all the insular or peninsular portions of the shore exposed to the full flow

of the Gulf Stream are almost equally peculiar in the southern character of their native flora. Thus in the rocky clefts of the Steep Holm the deep red blossoms of the true pæony may still be seen profusely in May and June, while it is found wild nowhere else in Europe nearer than the Pyrenees; and on Lundy the wild asparagus covers the granite of the shore in many places, though now almost extinct elsewhere in Great Britain, save perhaps at Asparagus Island in Kynance Cove near the Lizard, and some half-dozen other similar places. It would be easy enough to make a long list of such southern plants which still linger on in a few scattered spots of Devonshire, Cornwall, and Kerry—relics of the old flora of the submerged land between France, Spain, and Ireland; but perhaps a yet more interesting fact about Lundy is the fact that it has in all probability actually developed two new animals of its own.

Of course, the animals are not very large or very ferocious: if they were there would not be much room for them on Lundy. But an animal is an animal whatever its size may be, and the mere appearance of two separate animals on the rocky boss of Lundy, and nowhere else in the world, is certainly in itself a sufficiently surprising instance of local evolution. They are, in fact, nothing more than two small beetles. It is, of course, possible that these beetles may belong to the old fauna of the Bristol Channel, just as some of the plants almost certainly do, being found elsewhere on the Continent at the present day. But, on the other hand, it is far more probable, I think, that they are true natives of Lundy, sons of the soil developed on the spot; for it is well known that species are particularly apt to vary on

islands, and the more so the smaller their area and the more peculiar their climate. The intervening sea prevents free reinforcement of the original breed from the mainland; and so new varieties adapted to the special circumstances soon establish themselves, and before long grow into distinct species. Even in so large an island as Great Britain itself, but recently separated from the Continent, we have already one peculiar native bird—the Scotch grouse, which, as everybody knows, is not found anywhere else in the world; while we have several native butterflies, as well as dozens and dozens of incipient varieties, which may possibly establish themselves as species in the course of time. But in our smaller outlying islands, with their equable temperature and very insular character, including generally the absence of many common enemies—such as birds of prey, foxes, weasels, and so forth—numbers of separate local species have been noted by Mr. Wallace and other investigators. Thus, Shetland and the Isle of Wight have each a peculiar beetle of their own; Man has a dwarf butterfly and a tailless cat; Guernsey has a caddis-fly all to itself; and the Kerry Mountains (almost insular in climate and abounding in peculiar plants of southern type) have a water-snail. Almost every little island has also numerous local varieties. These cases are quite different from that of the Steep Holm pæony, which is merely a flower belonging to the great chain from the Caucasus to the Pyrenees, reappearing in an isolated spot in Britain; whereas the peculiar island animals are confined to these small areas, on which therefore they have presumably been developed. Furthermore, lakes are to the world of water what islands are to the world

of land ; and Dr. Günther has shown that almost every mountain tarn in Scotland, Ireland, and the Orkneys has its own peculiar species of trout or charr. Putting all these things together, then, it seems very probable that the two Lundy beetles have really been developed on the island itself from ancestral forms similar to those of England, but specially selected under the particular circumstances of the locality in which their lot was cast. If all the outlying eyots of Kerry, Connemara, and the Hebrides were equally well searched, it is extremely likely that dozens more and similar cases of insular species would be discovered without much difficulty.

XIV

THE CLOVER BLOOMS.

It is dry enough to-day to sit on the edge of the bank here, overlooking the sea, and watch the stone-boats loading great nodules of blue lias from the cliff to send away for cement in the two big clumsy coasting-vessels that ride awkwardly at anchor among the few small trawlers alongside our tiny quay. This long mound-shaped hillock on whose side I am seated bears among the children the fanciful name of the Giant's Grave ; and, indeed, at first sight you might easily take it for a huge artificial barrow of the oldest prehistoric type. It is in reality, however, a natural formation after all—an oblong mass of loose rubbly chert tumbled from the cliff above in winter weather, and long ago worn down by frost and rain to a round, smooth, level contour. Among the close-bitten turf on its shallow surface-soil, a little straggling and creeping white clover seems to form the chief element. I have known it well for years on this self-same knoll ; for it has a wonderful knack of clinging to any spot where it has once established itself ; which is not by any means surprising when one comes to learn its peculiar economy. It is a special form of clover adapted to dry sandy or gravelly pastures, but above all to shal-

low sheep-cropped sward like that of the knap here; and it has learned in a marvellous fashion how to protect itself against all the dangers to which the life of a fodder-plant is exposed in such difficult haunts.

The clovers as a group, indeed, are well worth an hour's study; and this particular clover is certainly one of the most interesting among them. I suppose it will sound like a paradox to say that these little creeping herbs rank as the most developed of all the pea-flower tribe; especially when one considers the tall tree-like laburnums, acacias, and locusts of our shrubberies, or the great stout-stemmed climbing wistaria on our garden-walls: yet such is the fact. The clovers have undergone a greater amount of modification to suit their special habits than any other species amongst them all. They are distinctly bee-flowers to a very high degree. Look at that big blustering humble-bee down on the level there: he is out this morning on a special hunt after clover-honey; for bees, like prudent human beings, never mix their nectars; they stick to one kind of flower at a time, and probably (though this is not yet certain) store each cell with a single sort of honey only. It is that which gives the higher insects their value as fertilisers: if they went about indiscriminately from one kind of flower to another they would do no good at all, or else would only produce monstrous and infertile hybrids. There are many volatile insects that flit about in this unconscious way from species to species; and those are the unwelcome visitors against which our flowers fortify themselves with all sorts of hairs, prickles, bristles, and scales. But now, on the other hand, just watch the humble-bee over there. He goes soberly about in the

most business-like manner from head to head of the red clover only, taking no notice at all of the creamy Dutch clover that grows in and out among it, nor of this little creeping variety that covers the surface of the hummock here. For a moment now he sniffs suspiciously at another red flower among the grass, much like his favourite for the day in tone of colour ; but it turns out to be only a vetch ; and he sails away with an obvious air of disgust, like one distracted from pressing business for a while by a bit of idle inquiry. Now he is buried deep in another head of red clover, sucking the honey quickly from each ripe purple floret, one after another, and passing by the over-ripe ones at once, without even a glance, like an experienced workman that he is.

Indeed, this particular English red clover is so wholly specialised to suit our own humble-bees that it cannot set its seed without them. The proboscis of the hive-bee is not long enough to reach the honey. In New Zealand, for many years it has been necessary to import clover-seed for each crop from England, because there were no humble-bees in the colony ; and so seriously has the want of these useful fertilisers been felt that several attempts have been made, not very successfully as yet, to acclimatise them in the islands. That is perhaps one of the most remarkable practical applications of what seems at first sight purely otiose scientific knowledge that has ever yet been made. I think it is Professor Huxley who quaintly remarks somewhere that the fertility of the clover in any district ultimately depends in part upon the number of old maids. For the clover is fertilised by the bees ; but the bees, again, are greatly thinned by harvest-mice ; and the harvest-mice in turn

are much devoured by cats ; and the cats, finally, are chiefly kept by old maids. The more cats, therefore, the fewer the harvest-mice, and the fewer harvest-mice the more bees. Omitting the old maids as perhaps too curious an addition to the series, the chain of causes and effects well illustrates the infinite and infinitesimal interaction, the constant cycle of relations, obtaining between every part of the organic world.

I pick a head of red clover and a stalk of this creeping white kind, to look into them a little more closely. First, let us begin upon the more normal red form. It is made up of some thirty or forty tiny purplish pea-flowers, each with a little red hairy calyx of its own ; the whole set of hairs mingling together below so as to form a perfect miniature forest, through which no thieving ant can possibly force his way to the honey store. Nothing bothers ants like hairs ; and Sir John Lubbock found that they could not climb up on to a table or safe if only a little fur was gummed around its legs. But though the florets of the clover are essentially pea-flowers, they are not pea-flowers of the common and ordinary type. They do not consist, like the blossoms of the garden-pea or the laburnum, of four distinct and separate petals : all their parts have grown together at the base by the claws, so as to form a single deep and narrow tube. That makes them such favourites with the bees : while, conversely, it is the constant selective action of the bees which has enabled them to assume this specialised form. The most tubular blossoms are those the bee always chooses by preference ; and when the tube is so deep and narrow as it is in red clover, the bee knows that no other insect can reach the nectar but himself, and so

feels sure of obtaining a guaranteed drop of honey as the reward for his services. At the same time, as the stamens have also coalesced with the petal tube, he cannot fail to fertilise the head while helping himself to the honey. This makes red clover a very successful plant, as you can easily see by looking about you in the fields anywhere. It also makes it good fodder; for as each flower has a pod with only one big bean or seed inside it, the whole head contains a large number of beans, rich in starches and gluten as foodstuffs. It is always the seeds that are the most useful for food; not the mere hard, stringy leaves and stalks. Everybody knows the difference in effect between a feed of oats and a feed of straw. Pulse, indeed, forms the most valuable set of fodder plants and human foodstuffs in the world, except only the grasses: because the seeds are almost always large and well supplied with albumen. Cows will turn aside from any grass to red clover. Observe, too, that these clover blossoms, like most other highly specialised bee-flowers, are purple. The common small pea-blossoms, such as nonsuch, lotus, kidney-vetch, and medick are all yellow; and so are even gorse and broom. Some of the smaller and simpler clovers, too, still retain this aboriginal yellow hue; but the better kinds, which have advanced further in specialisation for bees, preserve for us the various upward stages of white, cream-colour, pink, red, and scarlet, till at last we reach the highest level in these purple heads—the highest level, that is to say, yet attained by a clover; for no species of the genus has so far acquired the most peculiar bee-tint of all, which is dark blue or ultramarine, as seen in the violet or the bugloss.

And now let us look at the little white straggling kind of clover which grows all over the shallow grass of the knoll here. In shape, its florets are just the same long tubular blossoms as those of the purple clover ; but there are only two or three of them on each head, instead of forty or fifty. See how well adapted they are, however, to their habitat. The stems and leaves and buds creep prostrate along the ground, so as to get as much as possible out of the way of the close-biting sheep ; but the flowers turn up straight just at the moment of blossoming, so as to catch the attention of the passing bee. Both kinds are sweet-scented, like most bee-flowers, and with a very suggestive savour of honey in their scent too. As soon as the white kind has been fertilised, however, it turns down its head towards the ground, so as to save the swelling pods from the hungry sheep. At the same time the stem lengthens, and a very curious change begins to take place in the head. If you look close into the flowering branches, you will see a small green knob in the centre, between the three florets. This knob really consists of the other undeveloped blossoms which once formed the head, for it ought by descent to have at least ten or twelve instead of three. After the pods begin to set, and the stem to turn downward, these undeveloped blossoms grow out into short thick fibres, each five-fingered at the tip, as a reminiscence of the five lobes which once went to make up the original calyx. As the stem lengthens, the fingers push their way slowly into the loose earth with a screw-like action, and at last make a hole for the three pods, which have already turned back on their stalks, so as to offer as little resistance as possible to the soil.

Thus the plant actually buries its own seeds out of the way of all depredators; and there they ripen and lie securely till next spring's rain quickens them afresh. In this way alone could the subterranean clover—for that is its name—survive with safety in its shallow closely cropped pasture grounds. Yet how wonderful the action of natural selection here makes the plant simulate intelligence and volition. More than half the flowers have been altered into barren fibres to act as picks or augers in the earth; and the stem has acquired the habit of turning up, and then turning down: all for the sake of burying the three remaining fertile blossoms in the soil, and securing the safety of their few seeds. Indeed, it is often easiest to formulate the whole series of changes to oneself in such terms as one would naturally apply to a conscious and self-governing living creature; and it is this that adds such a charm to the new conception of nature which has been opened before the naturalists of the present generation by the evolution theory. We need no longer think of the plants as things that were made once for all: we may think of them as things that grew and improved and almost invented; and that idea immensely deepens the interest with which we can watch all their innocent ways and curious half-reasoning ingenious devices.

XV.

EARLY SEEDTIME.

It is wonderful to see how quickly the first spring plants manage to set and ripen their stock of seeds. Already one hasty crop has been duly shed, and now in this genial May weather the second detachment of early perennials is beginning to scatter its ripe fruit broadcast over the basking fields. Stage after stage, in regular succession, they follow one another like waves on the sea, each filling up a little special corner in the rural calendar, and each monopolising for the time some one or other of the active external agencies by whose aid vegetable life is necessarily carried on. Even now the three sets of buttercups are seen here on the farm in three stages side by side; the lesser celandine, earliest of the group, has blossomed long ago, and is now letting its ripe capsules fall one by one from the globular heads; the bulbous buttercup, next in order of time, still shows a few open flowers here and there, but most of them have dropped their petals, and have the green capsules just swelling with the young seeds; finally, the tall meadow buttercups and the creeping species, latest of the common kinds, are only now for the first time opening their golden buds. But the most conspicuous

seeds of all in the Fore Acre just at present are the dandelion clocks; and it is pleasant to sit in the sun and watch the wind taking off one little feathery parachute after another from the head, till the smooth round disc is left at last bald and naked. If we were not so accustomed to dandelion clocks from our babyhood upwards, they would certainly strike us as being very curious and interesting objects indeed.

If you pull a blossoming head of dandelion to pieces, you see at once that it is not a single flower, as it appears at first sight, but a whole collection of tiny separate florets crowded together in a bunch on a circular disc or cushion. Each floret stands complete in itself, with a tubular yellow corolla, a set of wee slender stamens, and a delicate two-lobed pistil in the centre, both lobes being curled round gracefully like a ram's horn. It has its own fruit, too: a small white object at the bottom, looking exactly like a single seed, as it practically is. In the daisy you get something of the same arrangement; only there the yellow florets of the central part are bell-shaped, like miniature hyacinths or heath-blossoms, and only the pink-tipped outer rays are split down one side so as to make their corolla more like a strap than a cup or bell. In the dandelion, on the other hand, the same tendency has gone a little further, and all the florets in the head have become strap-shaped rays, so as to let various small insects get easily at the drop of honey which each floret secretes in the nectary at its base. The daisy is a comparatively exclusive plant, which lays itself out mainly for distinguished visitors; the dandelion is a sort of common innkeeper, which welcomes all comers equally without regard to

rank or station. So we see the tastes of their different clients reflected in their own colours. The daisy has evolved white rays with pink tips to satisfy the eyes of a more æsthetically exacting circle; the dandelion retains the primitive yellow corolla of its kind, the hue that best suits the requirements of miscellaneous small flies and petty honey-seeking beetles. Each in its own way has proved very successful; for do not daisies and dandelions grow everywhere? But on the whole, as usually happens, the higher type is the most successful of the two. Both largely owe their advancement in life to their serried rows of flowers, which allow the bee or butterfly to pass from one floret to another with ease, and to fertilise many blossoms at once for a very small return in the way of honey.

All this, however, has very little to do with the dandelion clock, though it is necessary by way of preliminary to the consideration of those fluffy balls. The clock consists of the rest of the florets after the corolla has fallen off. The lower part, of course, is the seed, or rather the fruit: but what is the upper part, the little parachute of white silky hairs? Well, this curious appendage represents one of the most singular and instructive transformations in all nature. Pull out one of the blossoming florets from the yellow dandelion-head, and you will see it is surrounded by a circular group of small hairs. These hairs are all that remains of the original calyx, which had for its function the protection of the flower from intrusive insects. But when the dwarfed and clustered blossoms of the original ancestor from whom both daisy and dandelion are descended grew into a single compact head, the use of the separate

calyx was practically gone, and in its place a number of bracts were produced as an involucre around the entire head, subserving the same function for the compound blossom as the calyx once subserved for each of its component members.

Under such circumstances, one of two things must needs happen: either the calyx must become obsolete through disuse or must be preserved by adapting itself to a new function. In the daisy, the first result has come about: in the dandelion, the second. The calyx here has grown small and hair-like, and acts as a sail or wing for the light little fruit. Thus the wind catches the seeds when ripe and carries them away to every part of the field. In the simpler plants of the dandelion kind there are only a few of these silky hairs seated perpendicularly on the summit of the fruit, and the subsidiary devices for dispersion are far less perfect. But in the dandelion itself, which is a very highly adapted type—all these common weeds always are, and that is what makes them so common—the top of the fruit grows out into a long beak, on which the hairs spread laterally in a circle, so as to present the largest possible surface to the favouring breeze. Even in the dandelion, however, the hairs themselves are straight and simple; in its near relative, John-go-to-bed-at-noon, the hairs are much longer, and are subdivided into feathery branches on either side, which make an interlacing parachute even better adapted for driving before the wind than that of its more familiar kinsmen.

The reason why plants take all this trouble to get their seeds dispersed is a simple one; and yet it might not immediately strike everybody. Why should they

not let them drop out upon the ground just underneath their own branches? For the very same reason that the farmer does not crop the same land with corn or turnips ten years running. The plants had unconsciously discovered rotation of crops ages before the agriculturists consciously hit upon it. A weed cannot grow over and over again in the same place, any more than flax or horse-beans; it soon uses up the soil, which must then lie fallow a little, or else bear some less exhausting plant—that is to say, some plant that does not drain it of the same materials as its last occupant. Hence those wild things which happened to show any tendency towards dispersive devices have outrun all others in the struggle for existence; indeed, dispersion in some form or other has become an absolute necessity for every kind of plant in a state of nature. Some of them manage it by producing tubers side by side with the decayed ones, like the orchids; others send out runners or suckers like the strawberry and the creeping buttercup; yet others sprout afresh here and there from underground stocks or reserve stores, like coltsfoot or potatoes. But by far the greater number manage to get their seeds scattered for them either by the wind or by means of animals: for these two main motor powers of the environment are always utilised for every purpose by plants, whose own powers of locomotion are so very feeble. Sometimes the seeds stick, like burrs and cleavers, to the wool of sheep or the hair of animals, and are rubbed off at last against a hedge or a post, at a distance from the mother-plant. Sometimes they are swallowed whole but not digested, as in the strawberry, raspberry, and cherry. Sometimes they are carried before the wind by expanded

wings, as in the maple, the sycamore, and the ash. Sometimes they are borne up by light hairs or down, as in the willow, the cotton, and the dandelion. Occasionally even the plant itself supplies the necessary energy ; and of this the small green bittercress growing on the wall by Venlake affords at the present moment an excellent example. Bittercress has long, straight, upright pods, like charlock or cabbage, and it thrives for the most part on dry banks or high open places. When the seeds are ripe the sides of the pod unroll elastically, by the unequal drying of their stringy fibres ; and as they do so they shoot out the little seeds like popguns, and scatter them to a distance of six or seven feet ; as one can easily see by picking an unripe spray and spreading a newspaper on the floor around it when it ripens. Children well know this habit of bittercress, and will press their fingers on the tip of the dry capsules to make them explode ; if they are fully ripe they go off at once with a little bang. Garden balsams do much the same thing a little later in the season. Indeed, there is no plant which does not possess some special plan or other to secure fresh fields and pastures new from time to time ; and to trace these out is another of the pleasures that we countrymen derive from following the epochs of our rustic calendar. Every day brings its manifold changes, and almost all go unsung *carent quia vate sacro*. The little that one man can put on record is but a tithe or a hundredth part of the infinite variety they display.

XVI.

A SQUIRREL'S NEST.

I HAD long known there must be a squirrel's nest in the big tree at the corner of the avenue, for I have often remarked split shells of hazel-nuts lying about loosely at its roots ; and nut-shells split in such a fashion always indicate the presence of a squirrel. There are three creatures in England that largely feed upon filberts—the squirrel, the field-mouse, and the nuthatch ; and when you find an empty nut you can easily tell which of the three has been at it by the way they each adopt in getting out the kernel. The squirrel holds the nut firmly between his fore-paws, rasps off the sharp end by gnawing it across, and then splits the soft fresh shell down longitudinally with his long front teeth, exactly in the same way as a ploughboy splits it with a side-jerk of his jack-knife. The field-mouse presses the nut against the ground with his feet, and drills a very small hole in it with his sharp incisors, through which, by turning the shell round and round in his paws, he picks out the kernel piecemeal. The nuthatch, having no paws to spare, fixes the filbert in the fork of a small branch or the chink of a post, and pecks an irregular breach in it with his hard beak ; the breach being easily distinguishable from the neat workmanlike round gimlet-hole made

by the field-mouse. But although I knew the squirrel was there by circumstantial evidence, I had never seen him till after the great storm tore up the tree, roots and all, and strewed it, a huge ruin, right across the face of the park close by the gate-house. Even then he did not at once desert his home, before the labourers began hacking off the branches: when he quietly betook himself with his family to a neighbouring oak, whither he has since transferred by night the scanty remainder of his spring hoard.

The relics of the hoard are still to be seen in the abandoned hole, a deep recess where a gnarled bough had made a natural scar, improved upon with careful art by many generations of squirrels. There are acorn-skins, split shells of cob-nuts, beech-mast, and other mouldering spoils in plenty—the ancestral shards of many a winter feast. Indeed, it is curious how the trees and the animals have managed in this matter so cleverly to outwit each other in the see-saw of continuous adaptation. For the nuts have acquired their hard shells to get the better of the squirrels; and the squirrels have acquired their long pointed teeth to get the better of the nut-shells. Yet even at the present day, when the balance of victory apparently inclines for the moment to the side of the squirrel, the trees are not without their occasional revenge: since some nuts either prove too hard for the depredators or are forgotten in the abundance of supplies; and so it has happened that, in certain recorded cases, the existence of young seedlings in wild places has been demonstrably traced to an abandoned hoard, which has afforded a good supply of rich manure to the germinating embryos.

It is odd, too, how general among the rodents is this instinct of laying-by supplies for the winter, due, no doubt, in part to the exceptionally imperishable nature of their chief foodstuffs (for nuts, grains, and roots do not decay quickly, like fruits or meat), and in part to the usual close similarity in their surroundings and mode of life. We can hardly regard it as a habit derived from a single common ancestor, because it appears so sporadically, and so many related species are wholly wanting in it. Most probably it has been independently evolved in the squirrel, the harvest-mouse, the rat, the field-mouse, and the beaver, from the fact that in each group alike those who manifested it most would always best survive through the chilly and foodless northern winters. On the other hand, the storing instinct is sometimes replaced among allied animals by other instincts almost equally remarkable: as in the case of the dormouse, who gets over the same difficulty by fattening himself inordinately during the summer, and then sleeping away the winter so as only to use up the irreducible minimum of foodstuffs in the absolutely indispensable vital actions of the heart and lungs. From the point of view of mere survival, it would matter little whether any particular group happened to fall into the one practice or the other. It is very noticeable, however, that while the sleepiness of the dormouse has fostered, or at least has not militated against, a stupidity as great as that of the guinea-pig or the tame rabbit, the more active and provident habits of the squirrel and the beaver have fostered an amount of intelligence extremely rare among rodents, or, indeed, among animals generally. I once kept a tame squirrel for some months, not in a wretched little tread-mill cage,

but loose in my rooms; and in affectionateness of demeanour, as well as in general cleverness of perceptions, it certainly surpassed a good many dogs that I have known. Doubtless the habit of storing food grew up at first, as the west-country proverb says, more by hap than cunning. It may have originated merely from the thoughtlessly greedy practice of carrying home more food at a time than was needed for immediate consumption. Still, though the custom need not have been deliberately intelligent in its origin, it must have tended to develop intelligence in the animals displaying it; and even now it has hardened into an inherited instinct, it may often be a very conscious bit of prevision indeed with old squirrels who have seen more than one winter, and who know that nuts or berries cannot always be obtained with equal ease. At any rate, the fact that squirrels, rats, and beavers are now very clever animals is undeniable; and there is every reason to believe that their cleverness has been partly brought out by their provident habits.

Another thing that probably adds to the physical basis of intelligence in squirrels is their possession of a pair of paws which almost serve them in the place of hands. Mr. Herbert Spencer has pointed out that many of the cleverest animals are those which can grasp an object all round with some prehensile organ. Such animals, in fact, are the only ones that can really quite understand the nature of space of three dimensions. The apes and monkeys with their opposable thumb, the elephants with their flexible trunk and its finger-like process, the parrots with their prehensile claws, are all instances strictly in point. Even among the usually

stupid marsupials, the opossum has a true thumb to his hind foot, which he uses like a hand, besides possessing a very flexible tail; and the opossum is not only proverbially cunning, but he also has alone succeeded in holding his own among the highly developed mammals of America, while all the rest of his kind are now confined to Australia, their compeers elsewhere having been killed out without exception during the tertiary period by the fierce competition of the larger continents. Wherever we find a clever animal, like the dog, without any grasping power, we also find a large development of the sense of smell, which may be regarded as to some extent compensatory. But it must never be forgotten that the cleverness of the dog has been greatly increased by long hereditary intercourse with man, while the cleverness of the elephant, the monkey, and the opossum is all native and self-evolved. The squirrel's paws stand him in almost equally good stead. For though he has no opposable thumb, he can hold a nut or a fruit between them, rolling it about or adjusting it meanwhile: and his teeth also serve as regular tools, which further enable him to manipulate an object held in his paws almost as well as any other animal except the apes and monkeys. It is observable, too, that his tail belongs markedly to one of the two types common among forestine tree-haunting creatures. Those which crawl or hang among the boughs have generally prehensile tails to aid them in grasping the branches: those which run and leap from tree to tree have generally bushy tails to aid them in balancing themselves, and to act as a sort of aerial rudder. In the flying squirrels and many other similar exotic types the use of such tails as a parachute is supple-

mented by extensible folds of loose skin stretching between the legs or the fingers.

A group which shows so much variety of specialisation for its peculiar functions is likely to be an old one; and in fact the squirrels rank among our oldest surviving indigenous mammals. As a class, they date back as far in geological time as the lower miocene; and even our English species must have inhabited this country, practically unchanged in appearance or habits, for many thousands of years, except when driven temporarily southward by stress of passing glacial periods.

XVII

FOES IN THE HAYFIELD.

THIS week must be marked not with chalk but with charcoal in the Fasti of the farm, for one of our annual plagues has duly recurred in full vigour. The yellow-rattle has got somehow or other into the Three-cornered Croft, and nothing seems to be of any use to get rid of it. As a rule, one ought not to speak evil of plants behind their backs: but for a hungry, persistent, deliberate, designing, importunate parasite, your yellow-rattle has really no fellow. There is not a single redeeming point about it: it is ugly, useless, and uninteresting; and it makes a wretched living by fastening on the roots of grasses and draining them dry with its horrid clinging suckers. See here: if you pull up a tuft of meadow foxtail carefully, you find the rattle actually engaged in sucking its life-blood at this very moment. Rinse the two stocks together in the basin where the brook runs clear from the culvert for a foot or two to make a drinking-place for the cattle, and when the soil is washed away you will be able to see the actual mouths by which it fastens itself to the rootlets of its host. The hay in the croft will not be worth much this season: it seldom is; for rattle dwarfs the grasses terribly, and makes hard,

dry, stringy fodder itself into the bargain. There is nothing for it but stubbing the whole patch; and even that would be very little good, for the soil here exactly suits its constitution. Curiously enough, just over the hedge in the Fore Acre, there is not a single stalk of it to be seen, even by accident.

The rattles are a whole group of half-developed parasites well on the way to the worst stage of degradation, though not yet so utterly degenerate as the leafless toothworts or the scaly broomrapes. They can still grow feebly if left to themselves: for when you sow the seeds alone in a flower-pot, by way of experiment, the young seedlings will rise to an inch or two, put forth a few scrubby leaves, and blossom poorly with a couple of straggling flowers or so. But when you let them have some nice vigorous grass-plants in the same pot, they fix upon them immediately, and grow to a foot in height, with a comparatively fine spike of pale primrose flowers, which children sometimes know as cockscombs. Eyebright has just the same trick; and so have the two red-rattles, cow-wheat, and others of their kind. There are some parasites, like mistletoe, whose parasitism has become so deeply engrained that their seeds will not even sprout except on the body of a proper host; and these have adapted themselves to their peculiar habits by acquiring very sticky berries, which fall on a bough, and are gummed there by their own bird-lime. Even such a hardened offender as the mistletoe, however, has partially green leaves which assimilate food on their own account. But there are other and still more abandoned parasites, like yellow bird's-nest, which have no leaves at all, and cannot provide themselves with food in any way. Yellow

bird's-nest is a very rare plant in England—a degraded relation of the heaths, which has taken entirely to living on the roots of trees, sucking up their juices by its network of succulent rootlets. Its leaves have consequently shrunk by disuse into mere pale yellowish scales, not unlike those which one sees on the young shoots of blanched asparagus. Now, yellow-rattle and its kind deserve notice as showing the first step on this downward course: the initial stage through which the ancestors of the mistletoe must once have passed, and which the ancestors of the yellow bird's-nest must ages ago have left behind them. The plants are not in any way related to one another: on the contrary, they are extremely unlike, as far as pedigree goes; but they have all three independently acquired the same parasitic habits, and they all exhibit different stages in the same process of degenerescence.

Ancestrally, yellow-rattle is a near relation of the pretty little blue veronicas and of the big purple foxgloves and snapdragons. It has a flower of the very highest type—one of those curious one-sided mask-like blossoms with an upper and an under lip which are the product of special insect fertilisation and selection exerted throughout innumerable generations. Flowers of such a sort are the birthright of the most advanced families alone. But this particular snapdragon family is one of the most plastic and versatile in all nature. It may seem fanciful to say so, but there are certain groups of plants which really appear to be cleverer and shiftier than all others, to have a greater power of adapting themselves by strange side modifications to the most diverse situations. Perhaps one ought rather to say that

they are groups whose ancestors have undergone much variation, so that at last a tendency to vary easily has become hereditary with them all. Of such families, the orchids and the snapdragons are the most conspicuous ; and they differ so much and so quaintly among themselves that one can hardly avoid involuntarily attributing to them a sort of human spontaneity and deliberate design. Some of them mimic the forms and colours of insects ; others assume the most fantastic shapes and hues—apparently out of pure wantonness, but really in order to ensure fertilisation by the oddest and most improbable methods. The common snapdragon, for example, has the mouth of its blossom tightly closed by a projecting palate, so as to exclude all insects except the correlated kind of bee, whose weight as he lights on the lip suffices to press down the door and give him access to the sealed tube, with its nectar secreted in a little pouch at the far end. As soon as he flies away the palate snaps back again, and closes the entrance once more till another bee presents himself on the threshold. The yellow-rattle has just as complicated an arrangement on a smaller scale, with an arched and flattened upper lip, flanked by two purple-spotted wings, as well as a lobed lower lip, deeply divided into three distinct segments. The flowers are minutely arranged for fertilisation by bees ; and the insect is obliged to thrust his proboscis between the closely locked and hairy stamens in order to get at the honey. In doing so, he necessarily shakes out the pollen, which he carries away with him on his head to the next blossom.

In a very plastic and variable family such as this, the general plasticity seems to affect every part of the

plant. While the flowers still preserve throughout the same fundamental botanical type, they vary so much from kind to kind in all conspicuous outer peculiarities that a casual observer would probably fail to see any resemblance at all between them. Even this little minor group of half-parasitic root-suckers has several different shapes of flowers, each adapted in a particular fashion of its own to insect fertilisation. Again, their colouring varies widely. If you take a very simple and primitive group like the buttercups, you will find dozens of species all of the same golden yellow, and all uniformly coloured in every part of the flower. But if you take a family like these snapdragons, you will find no two species coloured alike, and most species wonderfully spotted and dappled with mingling yellow, blue, and purple. Once more, the leaves vary immensely: each kind hits out a separate type for itself, and adapts it exactly to the soil and sunlight of its particular situation.

With such universal plasticity of constitution as this, it is easy to understand how the parasitic habit could have been acquired and maintained. The little eyebright which grows so abundantly on roadside commons is still, perhaps, in the earliest stage of the practice. Its flowers are most like the blue speedwells, though much streaked with red, white, and purple; and its roots only suck nutriment slightly from the thin rootlets of the grasses about it. It does far less harm in meadows than yellow-rattle, and is hardly recognised by farmers as a distinct enemy at all. Next to it, apparently, come the two red-rattles—marshy plants with much more specialised flowers, and queer fleshy jagged leaves: they also do but little practical damage, because they frequent

swamps, and feed only at the expense of the rank grass in water-logged patches of meadows. Then come the still more parasitical cow-wheats, very injurious to standing corn, but happily rare in England except on the south-east coast. In Norfolk, purple cow-wheat is a regular pest, one of the worst possible corn-field weeds, and very difficult to eradicate, since it sheds its seeds before the harvest is reaped. This plant shows in an incipient form the common tendency of advanced parasites to lose the greenness of their leaves; and when once a weed has finally reached that depth of degradation it must feed for ever in future upon the juices of its host, having no chlorophyll of its own with which to assimilate starches for itself from the air. Last of all, yellow-rattle completes the list, and draws more than half its sustenance from the throttled grasses on which it fastens. In time such plants may sink to the absolutely leafless condition of broomrape or tooth-wort.

If so, however, they must acquire some plan for diffusing their seeds more widely and more certainly, so as to fix themselves from the first on the tissues of some other weed. At present the seeds of rattle are large, flat, and winged; and when ripe they clatter about noisily inside the swollen calyx and pod, till a high wind blows them out and away. Children shake the pods to make them rattle, which gives the weed its common English name. The variability that has made the whole family what it is may still be marked with our own eyes: for both rattle and eyebright have so many varieties and transitory forms that they have been split up into numberless separate races by botanists with an

itch for seeing their own names as authorities at the end of a new species. When there is much variation some forms are sure to possess small points of advantage; and it is these small points that natural selection soon fixes into permanent characteristics of new races.

XVIII.

HAYMAKING BEGINS.

THE early season has told upon the hay more than upon any other crop this year, perhaps; and the thick swathes are already lying in long parallel curves upon the bulging side of Stonebarrow Hill. There is no more beautiful sight among all the beautiful sights of the country than to see the scythes following one another in measured rhythm along a convex undulation on the hill-side, and to watch the swathes forming, as if by magic, in regular ranks behind each mower as he moves quickly and skilfully across the transformed field. It is a graceful combination of natural beauty and simple human art: a combination in which each rather adds to than diminishes the effect of the other. Behind the mowers, in the still uncut portion of the meadow, the grasses sway and bend before the wind in broken curves—looking almost as though the whole mass were moving swiftly like a river in the direction of the breeze. But in the foreground, the long even line of the mown edge stands up sharply like a wall with human regularity; and still nearer, the great sweeping rows of fresh hay lie one in front of the other with human consecutiveness. In the level field that fills up the alluvial valley

below, one can see the same thing more strikingly displayed : for there the crop is crimson clover, a wide expanse of such colour as we rarely find on English meadows ; and it has been cut into squarely for fresh fodder, so that a great rectangular patch of green runs abruptly into the serried ranks of wind-swept crimson heads. Add the mingled scent of the new-mown hay and the still-flowering clover, and you have such a profusion of rustic sense-pleasures before you as satisfies the vacant mind with that monochronic hedonism which, in spite of the ethical philosophers, is, after all, one of the purest charms in our little human life.

Hay, say the dictionary-makers, is dry grass ; and yet it is curious, when you come to look into it, how small a portion of the sum-total the grass itself really makes up. To be sure, grasses form the tallest and most conspicuous part of the herbage : their tufted heads, now purpled with the downy bloom, overtop all the shorter ingredients, and so of course strike our eyes most forcibly as we gaze across the swaying and surging mass. But in truth they are only that element in the meadow which has been forced upward by the competition of the other kinds ; they have tall thin blades adapted to the circumstances ; and they must get their spikes of blossom well above the interfering things at their base, because they are wind-fertilised, so that they want abundant free space for the pollen to be wafted from head to head. If you look closely into our English greensward anywhere, you will see that all the grasses put together hardly make up one-half of its component elements.

See here in the pasture, a large part consists of

buttercup stems, uncropped by the cows; of plantains, with their ribbed leaves almost rivalling the blades of the grasses; and of little spreading daisies, with their close rosette of foliage pressed hard and tight against the naked ground, so as to prevent the struggling young seedlings of the grass from pushing their way between the overlapping tufts. It is just the same in the meadow: there, in between the haulms of grass, you get a thick and matted undergrowth of Dutch clover, yellow medick, and rusty-red sorrel, besides all the taller meadow flowers—such as buttercups, corn poppies, and ox-eye daisies. These last make up a large and curious group, the true weeds of cultivation. They are as purely of human origin in most cases as wheat or barley: they have assumed their existing shapes under the influence of man's handicraft. And yet they differ in one important particular—that they are dependent upon him involuntarily instead of voluntarily: they are results of his weakness, not of his strength.

Take first these two wild yellow weeds by the hedgerow as examples of what man's definite and intentional selection has done. A casual observer would hardly know them from charlock; for they have much the same golden flowers, and grow in much the same straggling weedy way; but their leaves have no stalks, and even in the rougher of the two they are far from being so prickly to handle. This one with the bluish tinge upon its foliage—a Greek would have called it glaucous—is wild cabbage; and from just such a tall, stringy weed as that, all stalk and no heart, constant human selection has developed not only all the garden cabbages, red or white, but *hoc genus omne*—cauliflowers, broccolis,

kales, Brussels sprouts, and fifty other varieties as well. Over-feed and over-breed the leaves, and you get at last a cabbage; over-nourish the flower-buds, and you get at last a cauliflower. Again, this other scrubby plant, with tails to its leaves clasping the stem, is the origin of all our turnip kinds In itself, it differs almost inappreciably from the ancestor of the cabbages; but its tap-root is just a trifle fuller and rounder; and hence, when primitive man first pulled it up, he did not eat its prickly leaves, but boiled its round underground knob instead. So, too, when he began to cultivate the two weeds in his little garden patch, he selected his cabbages for their hearts and his turnips for their roots. But so plastic are all these forms, that while later man has made the wild root turn into a cultivated turnip for himself and his sheep, he has made it turn equally at will into a swede for his cattle, and he has developed it into a rape-seed for the manufacture of his colza oil. Let any one of these artificial varieties alone on its own resources, and after a few generations it will revert to the original wild cabbage or wild turnip, as the case may be. But if we found the different cultivated plants all growing in a wild state we should say not only that they were good species, but also that they were much better species than the wild cabbage or the wild turnip from which they sprang. The cultivated varieties differ more amongst themselves than their wild originals differ from one another.

Now, unconsciously and involuntarily, man has similarly altered many wild plants which grow, or once grew, upon his cultivated plains. By tilling almost all the alluvial lowlands and prairie stretches of Europe and

Asia, and still later of America, he has produced such a series of changes in the native plants that many of them have become at last pure weeds of cultivation. There are some, like pimpernel and shepherd's-purse, that we only know in this form ; they grow always on cultivated ground or waste patches, and their truly wild types are now utterly extinct and irrecoverable. None are more peculiar in this respect than the weeds that frequent cornfields and meadows ; and perhaps their most marked peculiarity is their exact synchronism with the grass or the wheat among which they grow. All of them spring up together, flower together, and ripen their seeds together. They are cut down with the crops ; their seeds are sown with the crops ; and they are carried to all parts of the world with the seed-corn and the grasses. At first sight people are inclined to say that this is pushing a true principle too far : cultivation, they think, has existed on the earth for so short a period that natural selection has not yet had time to act upon its concomitant weeds. They might almost as well object to an account of a shipwreck in which only the best swimmers escaped, on the ground that in those few minutes natural selection would not have time to single out the bravest muscles and the strongest thews. There are circumstances in which the selection is absolute and instantaneous—as, for example, in prairie-fires or submerged islands. The annual cutting of the corn and the grasses acts almost as absolutely and effectively. From year to year, at a relatively fixed date, every plant in vast tracts of cultivated country is cut down and carried away from the fields. Most of these plants are peculiar to the tilth of the lowlands ; they are different

in type both from the woodland flowers and from the hedgerow weeds. Hence their only chance of survival is by exactly adapting their own habits to those of the food-plants among which they dwell.

In the beginning, no doubt, they varied greatly in their periods of development; some were earlier and some later. But every weed which ripened its seeds too late would naturally be cut down green, so as to perish utterly; while every weed which ripened them too early would stand a fair chance of having them buried beneath a whole sod's thickness of ploughed land. Thus only those which happened exactly to tally in time with the corn or the grasses would succeed on an average in keeping their position; so that at last the farmer often positively sows corn-cockles and thistles broadcast with the grain that he scatters on his fields. They go with the seeds to America and Australia, and they live down the native plants in New Zealand or the Cape Colony. What we see in this illustrative example of their seeding is equally true in all their other peculiarities. They have been compelled to adapt themselves to the new conditions by such a stringent selection as seldom or never occurs in natural circumstances. Prairie-fires or inundations take place once in an age, on a single spot at least; but the annual ploughing of the fields does almost as much every year as these catastrophes can accomplish in a whole century. Indeed, no form of selection is really so severe as that thus unconsciously exercised by man. And when we remember that he has tilled and reaped cereal grains ever since the days when he ground his flint hatchets beneath the primæval beech-forests of prehistoric Europe, it is not surprising

that appropriate interloping plants should have had time to develop themselves in his cultivated patches. However small those patches were, they must from the beginning have possessed their own peculiar types of weeds.

XIX.

THE MOLE AT HOME.

HERE in the barton of Colway Farm I have just come across the farmer's museum—a barndoor with dead weasels nailed against it for a warning to evil-doers; which museum also contains the warped skins of no fewer than eleven indigenous British mammals, including bats, shrews, water-rats, moles, and harvest-mice. As I stand by the barndoor examining the dried and withered skins at leisure, young Tom Wootton comes up with a basket of something or other on his arm. 'What 'ast got there, Tom?' I ask him, in our native West Saxon tongue; and Tom, with a broad grin on his face at the question, answers, 'Wunts, zur, wunts to hang up along-zide o' they others.' Perhaps it may be necessary to inform the untutored dwellers in cities that wunt or wont is the good old English name of those underground animals which we nowadays chiefly know as moles. Tom is wunt-catcher by appointment to the farm, and he has just made a capture of half a dozen from the troublesome runs in the Home Fields. I take one of the poor things out cautiously by its short stumpy tail, and examine it all round with a critical eye.

It is a curious creature, to be sure, this mole, and

one of the best examples of the kind of wild animals that still manage to drag out a miserable existence in English meadows or pastures. The mole is in structure an insectivore, one of that great central mammalian order which best keeps up for us to the present day the primitive peculiarities of the whole class of mammals. They have all small brains, and very little developed limbs or organs. They are the least specialised of all quadrupeds, the kinds which have diverged the least from the first ancestral rough sketch of the mammalian type. Compared with a horse, a deer, an elephant, or a cat, one feels at once that moles, hedgehogs, and shrews are very simple and undeveloped forms. Even externally they have not the formed limbs and highly modified weapons or extremities of these higher animals ; instead of a solid hoof they have five rude simple claws ; instead of powerful tearing teeth they have a weak and primitive dentition ; while of course they have no such peculiar appendages as horns, antlers, tusks, a trunk, an opposable thumb, or a prehensile tail.

This simplicity and central character in their outer shape is answered by an equal simplicity in anatomical characters. They are, in fact, a few skulking representatives of a very early type, which do not come into competition with the higher and later forms because of their nocturnal or underground habits, and so survive comparatively unchanged ; while all the better places in the hierarchy of nature are filled by more advanced and specially adapted creatures.

On the other hand, if you look closely at this mole, you will see that while in general type it has varied but little from the primitive mammalian ancestor, it has yet

undergone modification in many small points of some importance, so as closely to adapt it to its existing mode of life. The insectivores, *qua* insectivore, are intensely primitive, but each one of them, *qua* mole, or water-shrew, or hedgehog, is a very specialised kind of insectivore indeed. This mole here, for example, has a pair of naked, flat, and powerful forepaws, turned curiously outward, for shovelling out the earth from his tunnels ; they look singularly like the human hand, and are wholly different from the webbed fingers of the oared shrew, or the simple flat feet of the hedgehog. Ages and ages ago the ancestors of the mole took to burrowing in the ground for a livelihood, and all their structure has long since been accommodated by use and wont or by natural selection to their peculiar habits. It is easy enough to see, indeed, how a burrowing insectivore might readily acquire the special mode of life now so deeply ingrained in the race of moles. At first, no doubt, it would take to digging a hole in the earth simply for protection, like rabbits and mice ; but, as it must thus necessarily come across the long tunnels and nests of Mr. Darwin's friends the earthworms, it would naturally eat these congenial morsels of food, which a herbivore like the rabbit could not touch. A certain number of such original undifferentiated ancestors of the mole would be sure to find an easier living by hunting the worms underground than by looking for beetles and slugs on the surface, like the hedgehogs, especially if they happened to be of a powerful muscular build. The habit of digging rapidly through the ground would increase their strength from generation to generation ; and natural selection would co-operate with habit by weeding out all those individuals whose

paws or shape was less adapted to burrowing, and preserving those which best fulfilled the new conditions of existence. The strongest prototypical mole, with the biggest shovel-shaped forefeet, and the sharpest snout for extracting the worm from his circular tunnel, would obtain the greatest quantity of food, and starve out his less developed competitors. So in time all the existing peculiarities of the species would come to be evolved, till at last each country possessed a mole exactly adapted to its own special varieties of soil and earthworms.

Our own English mole has now acquired a shape and structure admirably fitted to his station in life. He has immensely powerful muscles, which enable him to plough through the soil with astonishing rapidity, as anybody knows who has once seen the earth heaving and swelling beneath the turf where he is at work constructing a new tunnel. In order to make up for this immense expenditure of energy, he requires a proportionately enormous quantity of food ; his appetite is positively ravenous, and he starves if forced to fast for only half a day, except during his brief period of hibernation. As a rule, he works for three hours at a time, then rests three hours, then works again, and so on perpetually. His fur is very thick and close, so as to prevent dust from getting at the skin ; and it is extremely soft, so as not to rub against the burrows and cause vibrations in the earth, which, as Mr. Darwin has shown, frighten away the timid worms. His slender snout both forms a wedge to loosen the soil and enables him the better to pick his clinging prey from its narrow concreted tunnel. On the other hand, an eye is almost useless to

a subterranean creature, and so it has become practically all but obsolete, being quite buried beneath the skin. In all probability it is only sensitive to the presence or absence of light, not to definite forms and colours. Like most other miners, he dearly loves a fight, for which purpose he meets his rival above-ground by night, and does battle with a fierceness and pugnacity that are truly astonishing.

The mole has a certain number of regular paths, along which he makes his way rapidly and noiselessly through his hunting-grounds, catching all the stray worms that chance to be passing on the way ; for, after a burrow is once made, it remains open all that season as a sort of permanent pitfall, intersecting many worm-tunnels. During winter, or at least in times of frost, he retires to what is called his fortress, containing a circular nest, with one or two irregular galleries for escape, in case he is attacked by man or carnivores. The very symmetrical ground-plan of these fortresses, however, which has been copied over and over again in popular books from a sketch by an imaginative French naturalist, seems to me ridiculously overdone in the matter of systematic completeness. The real fortress is comparatively a very simple matter—I have seen Tom open dozens of them—and has only a few quite casual-looking passages instead of the complicated circular galleries with equidistant exits and five internal communications shown in the well-known picture. While the frost lasts the hungry animal lies coiled up dormant in this hibernating chamber ; but the moment a thaw sets in, and the worms can get about once more, he is out at once, and you can track his path everywhere through the

meadows by his numerous little mounds of soft fresh mould. As an enemy of our benefactor the earthworm he is no doubt fair sport for man ; but I often fancy he must do much good in his way, too, by loosening the soil and letting it crumble down and mellow in the open air.

XX.

JULY FLOWERS.

SEE here, straggling over the tall weeds on the bank, to which it clings by its twining curled tendrils, I have lighted on a graceful spray of the true vetch, with its pretty purplish pea-flowers and its long, shiny, grass-green pods. It is a common plant enough, this southern vetch; for though it is not an aboriginal inhabitant of Britain, it has been cultivated for fodder so long in our meadows that it is now perfectly acclimatised, and spreads readily like a native denizen among pastures and waste patches. But what gives it a special interest at the present moment is that I have caught it, so to speak, in the very act, helping to verify an old surmise as to the true purpose of these little black spots on the flaps or wings that guard each separate flower-stalk. At the point where the blossoms spring from the stem you will notice two small barbed leaflets—stipules we call them technically—each with a round dark patch in its hollow centre. Now, if you look at them closely, you will see that the dark patches are moist with some viscid substance; and if you taste it you will find that it is nothing more or less than a drop of pure honey.

On this particular vetch-vine, however, each of these

leafy nectaries is now being eagerly attacked by small black ants, who are greedily sipping up the honey as fast as it exudes. There cannot be much doubt that that is the very purpose for which the nectaries are put there. Ants are known to be terrible honey thieves ; and they are perpetually trying to get at the store of sweets which the plant has laid by in the base of its flower to allure the fertilising bees. But any flower which is thus rifled will never be visited or impregnated by insect visitors ; and so those plants whose structure aids them by any chance trick or sport in baffling the ants will be the only ones that can set their seeds and become the parents of future generations. Hence, almost all honey-bearing flowers have inherited some peculiar modification of structure which enables them to set at defiance all such creeping marauders. Many of them have stalks covered with long hairs—often star-shaped at the end (as one can see even through a little pocket lens), or tipped on top with small, round, sticky glands. Now, there is nothing that bothers ants so much as hairs : they seem as incapable of getting through them as a cow is incapable of getting through a thickset hedge. Other plants, again, secrete a gummy exudation on the stem, in which the wretched foragers get clogged and slowly killed, like flies on a plate of treacle. But the vetch has few hairs and no sticky glands, so it tries to bribe the ants by throwing them a sop instead. The nectaries on the stipules distract them from the flowers ; and if you watch you will see that the ants never mount the slender flower-stalks at all, but go straight up the main stem from one such extra-floral honey-gland to another. No doubt they never discover the existence of the real flowers at all.

Thus, by the sacrifice of a little sugar at the base of each flower-stalk, the vetch secures its precious blossoms from robbery and consequent barrenness. Curiously enough, there are two nascent varieties of this common vetch, not yet fully differentiated into species—one of them hairy while the other is smooth ; and in almost every case the hairiest specimens, being already sufficiently protected by their forest of tiny bristles, secrete little or no honey. Probably they are now in course of acquiring the habit of doing without it.

The immense variety of adaptation to external circumstances in the same family, indeed, is nowhere more conspicuously seen than in our English peaflowers. Fundamentally, they are all so like one another that even the most unlearned eye at once admits their relationship ; for who cannot recognise the close similarity between peas and beans, gorse and broom, vetch and clover ? Yet almost all of them, while retaining at bottom the fundamental ancestral traits, have hit out the most diverse plans for accommodating themselves to their own particular circumstances. For example, there are four July pea-blossoms now in flower which have four distinct and separate types or methods for ensuring insect fertilisation. In this bright yellow lotus, that covers all the bank with its clustered masses of gold, the pressure of the bee pumps out the pollen through a small aperture at the top against his breast. In the broom and gorse, his weight makes the whole flower burst open elastically, and dusts him from head to foot with the fertilising grains. In the clovers, the stamens are pushed bodily against the insect's bosom so as to shed their store upon his legs. Last of all, in the peas

and vetches the pollen is swept out as he lights, by a brush of hairs on the surface of the pistil.

Each of these main types assumes specialised minor forms in the various genera and species, according as they have peculiarly adapted themselves to hive-bees or humble-bees, to flies or to beetles. It is much the same with their fruits or pods. This vetch here, as we all know, is largely grown for fodder, because of its rich pea-like seeds, well stored with starches and albumens for the growth of the young plant. Indeed, the pea kind ranks next to the grasses as a producer of human foodstuffs—supplying us with peas, beans, lentils, and many other well-known pulses. But these rich seeds are always much sought after by animals as food ; and therefore the plants have been driven to devise the most curious plans for thwarting their enemies : or, in other words, those which showed any tendency in the direction of producing inedible pods have thereby gained an advantage over their competitors and survived accordingly. Here, for example, is a sprig of yellow nonsuch, a clover-like trailer grown in the meadows as an 'artificial grass,' because of its rich little beans, concealed in the small black kidney-shaped pods : this is a relatively ill-adapted form, largely preserved by man's providence. But here again is a bit of the truly wild medick, a closely allied plant, which farmers hate ; for the cattle will scarcely touch it, so sternly has it armed itself against their dreaded depredations. In leaf, flower, and general appearance the two are typical pea-plants, differing but very little from one another. But in their fruit they are extremely unlike. The medick has a long curved pod, completely twisted round and curled tightly up into

close spiral, so that it looks more like a little brown ball than a common pea-pod. All round the edge this ball is thickly defended by double rows of stout hooked prickles, which naturally make it about as unpleasant to the mouths of the cattle as a burr or a thistle. The subterranean clover is another pea-flower, which solves the same problem in a different way by burying its own seeds beneath the sod. And this wee creeping bird's-foot, which, like many of its small congeners, has to fear the birds more than the sheep or cattle, avoids opening its pod to shed its tiny beans by making it solid all round, and then dropping off, as it ripens, into little articulated pieces, each containing a single seed. The pod, in fact, divides at the joints between the beans, and so disappoints the birds, who always wait in other cases till the valves burst open. Wild radish, or 'jointed charlock' as the farmers call it, has independently adopted the selfsame plan in the widely different family of the cresses. As to peculiarities in the number and shape of the seeds themselves, the hairiness or smoothness of the pods, the colour and consistency of their coverings and so forth—among the peaflowers alone they are practically innumerable; and each has its own definite purpose, generally discoverable in the end by a little careful observation and minute comparison.

The leaves, again, vary immensely, though always strictly by derivation from a single ideal or ancestral type. The typical leaf of the pea-kind has a central stalk, with little leaflets arranged in opposite pairs along its course, and a similar terminal leaflet at the end. This is the form the foliage still assumes in lady's-fingers, bird's-foot, and many other species. But in the clovers,

and similar stunted creeping meadow plants, there is not much material to spare upon the leaves, and so they only develop one terminal leaflet with a single pair of lateral ones beneath it: in other words, they are shortened into trefoils. The complementary leaflets on each stalk remain always undeveloped. In these vetches, again, and still more in the true peas, it is the terminal leaflets that are wanting; and in their place the end of the common leaf-stalk lengthens out into twining tendrils, which help the branches to creep over other plants, so as to gain a decided advantage in the struggle for life over the little procumbent clovers.

Sometimes among the peas, however, circumstances call for a different modification; and then we get all sorts of curious distortions or abortions, as the case may demand. Thus the beautiful pink grass-pea, growing among tall blades on borders of fields, requires foliage like the grasses themselves, in order to compete with them on terms of equality; and it has achieved its end by dwarfing the leaflets till they have disappeared altogether, while at the same time the denuded leaf-stalk has flattened out into a broad blade, exactly imitating the grasses among which it lives. In its close relative the yellow vetchling all the true leaves are reduced to a long tendril; but to make up for them the barbed stipules or flaps, normally mere tags about a quarter of an inch long, have grown out into a pair of expanded and heart-shaped green leaves. Here we must suppose that from generation to generation the original leaflets got less and less work to do, and so gradually died away by mere disuse; while at the same time the leaf-stalk in the one case and the stipules in the other grew larger and larger

to perform their new functions, because such organs were better able to perform them under those peculiar conditions than the ancestral leaflets, derived from a progenitor of very different tastes and habits. Strangest of all, in gorse the leaves assume the guise of stout green thorns ; though the young seedlings have first trefoil foliage like the clovers, and only gradually produce more and more lance-shaped blades as they reach the adult condition. Here protection from animals is obviously the object in view. Yet so rich is nature that all these varieties of flowers, fruits, and leaves occur within the limits of a single family ; and they may all be observed together at this very moment in the July meadows or commons of southern England.

XXI.

CHERRIES ARE RIPE.

THE big whitehearts on the first tree in the orchard are just beginning to blush in ruddy streaks on the sunny side, and the wasps are already finding their way to the softer red pulp of the ripening bigaroons by the further hedgerow. Altogether the little mixed cottage orchard makes up a very pretty picture at the present moment. The gnarled old apple-trees, their limbs thickly covered with dry grey lichen, are now in full summer foliage; and the green and grey, seen from a little distance, melt together into a beautiful mass of soft subdued colour. The late pink hawthorn is still in half-faded blossom; the elder is one sheet of white bloom; while the cherries are rapidly mellowing into pink and crimson. No fruit, indeed, except perhaps the orange, is prettier or more tempting as it hangs on the tree than our English cherry. Besides, it is a son of the soil, a native born; and, in spite of all that gardeners can do, our real indigenous fruits thrive better to the last in English mould than any imported aliens. The cherry trees of our orchards spring, in fact, from two separate wild British stocks. The common dwarf cherry, whose large white blossoms often hang out of thickets and copses in early

spring, is the ancestor of morellos, dukes, and the Kentish kind ; the taller gean, found wild only in the southern counties, is the strain from which we get our bigaroons and other sweet table-fruit. Selection can do wonderful things ; but it absolutely requires the positive basis of natural variation to work upon. Though it would be quite possible to make a serviceable fruit out of a haw or a dog-rose, we may well doubt whether in untold ages man could ever make a serviceable fruit out of a heath or a thistle. So far as we can judge, the natural variations which tend towards succulence and pulpiness never seem to manifest themselves at all in the group of plants to which the heaths and the thistles belong.

It is quite otherwise with the tribe of roses : including not only the peach, the nectarine, the plum, and the cherry ; but also the strawberry, the blackberry, the raspberry, the cloudberry, the apple, the pear, and the mountain-ash as well. Throughout all this family a strong native tendency exists towards the spontaneous production of juicy fruits. The roses, in fact, are the great fruit-bearers of the world ; just as the grasses are its grain-producers, and the catkin tribe its manufacturers of solid timber. It is interesting to decipher anew the steps by which the chief groups of plants and animals, afterwards turned to account by man for his own purposes, were originally developed, quite apart from his future needs, by the interaction of an environment in which as yet he bore no share. Just as at the present day, when he settles in a new region teeming with untried natural productions, he exploits them all for his own service ; draining gutta-percha here,

extracting dye-stuffs there, and discovering new starches in yam or sago-palm, potato or cassava yonder—so at his first appearance upon earth he took in hand the various things already evolved in it by pre-existing agencies, and moulded their properties as best he might to his personal uses. Each of them had a function of its own in reference to the needs of the organism to which it belonged: man adapted them to his special human wants.

But the ultimate origin of the pulpiness in plums and cherries was quite antecedent to any particular adoption of their stocks in the primitive orchards of early man. So far as we can now tell, the roses do not date back in time beyond the tertiary period of geology. The very earliest members of the family still extant are little creeping herbs, like cinquefoil and silver-weed, with yellow blossoms (all primitive blossoms, indeed, are yellow) and small, dry, inedible seeds. The strawberry is the lowest type of rose above these very simple forms. It is still a creeping herb, and its seeds are still small, dry, and inedible; but they are embedded in a juicy pulp which entices birds to swallow them, and so aid in dispersing them under circumstances peculiarly favourable to their due germination and growth. Next in order after this earliest rude succulent type (nature's first rough sketch of a fruit, so to speak; and a very successful one too, from the human point of view at least) come the blackberry and raspberry; where the individual fruitlets grow soft, sweet, and pulpy, instead of remaining dry as in the strawberry. And this change clearly marks a step in advance; so that blackberries and raspberries are enabled to get along with fewer

seeds, and yet to thrive much better in the struggle for life too—seeing that they have developed into stout woody trailers, often forming considerable thickets, and killing down all the lesser vegetation beneath and between them. Again, the dog-roses show still higher development, alike in their erect bushy form, in their large pink flowers, and in their big scarlet hips—which are uneatable by us, it is true, but are great favourites with birds in severe winters. The haws of the whitethorn are even more successful in attracting the robins and other non-migratory allies ; and the whitethorn has been enabled, accordingly, to reduce its seeds to one or two, each enclosed in a hard, bony, indigestible nut. Finally, at the very summit of the genealogical tree, we get the plum tribe, highest of all the roses ; growing into considerable arborescent forms (though in this respect inferior to pears or apples), and producing large, luscious, pulpy fruits, with a single stony seed, admirably adapted to the best type of dispersion, and never wasting a solitary germ unnecessarily, as must be continually the case with its small dry-seeded congeners the silver-weeds and cinquefoils. Not, of course, that this pedigree must be accepted in a linear sense (indeed, the roses early in their history broke up into at least three distinct lines, which have evolved separately on their own account, and have culminated respectively in the plums, the true roses, and the apples) ; but it illustrates the general method of their development, and it shows the strong tendency which they all alike possess towards the production of sweet pulpy fruits in one form or another.

If you look for a moment at a ripe cherry—by preference a red one, as being less artificial than the pale

whitehearts—you will see how well it is fitted to perform the functions for which the tree has produced it. It has a bright outer coat, to attract the eyes of birds, and especially of southern birds—for England is near its northern limit, and it is a big fruit for our native species to eat; rowan-berries, haws, and bird-cherries are rather their special food in our northern latitudes. Then, again, it has a sweet pulp to tempt their appetite: sweetness and bright colour in plants being almost always directly traceable to animal selection. But inside, its actual seed is protected by a stony shell; while its kernel is stored with rich food-stuffs for the young seedling, laid by in its thick seed leaves, which form the two lobes of the almond-like embryo. The flower, it is true, has a pair of separate ovules, which ought, under ordinary circumstances, to develop into two seeds; but as the fruit ripens one of them almost always atrophies. Such diminution in the number of seeds invariably accompanies every advance in specialisation, or every fresh forward step in appliances for more certain distribution. The little hard nuts on the outside of the strawberry number fifty or sixty; the nutlets of the raspberry number only some twenty or thirty; the pips of the apple, relatively ill protected by the leathery core, range from five to ten; the stones of the haw, with their bonier covering, are only two: but in the plum tribe, with their extreme adaptation to animal dispersion, the seeds have reached the *minimum irreducibile* of one.

It is this highest tribe of all, accordingly, that supplies us with what we call distinctively our stone-fruits. The sloes of the common blackthorn have grown under cultivation into our domestic plums; the two wild cherries

have grown into our morellos and bigaroons ; while an Eastern bush has been gradually developed into our more delicate apricots. The old-fashioned botanists have thrust the peach and nectarine into a separate genus, because of their wrinkled stones ; but common sense will show any one that it would be much easier to get a peach out of an apricot than to get an apricot out of a plum : and, indeed, these artificial scientific distinctions are fast breaking down at the present day, as we learn more and more about the infinite plasticity of living forms under cultivation or altered circumstances. Even the almond, different as its nut appears from the plum type of fruit, is really a plum by origin ; for in all other particulars of flower, leaf, and habit it closely resembles the nectarine, from which it has diverged only in the solitary specialty of a less juicy fruit. We know how little trouble it takes to turn a single white may-blossom into the double pink variety, or to produce our distorted flowering almonds and our big many-petalled roses from the normal form : it takes very little more trouble for nature to turn an apricot into a peach, or to produce a dry shell-covered almond from a juicy nectarine. Only, since nature acts more slowly, and since her conditions remain approximately the same throughout, her new species do not tend to relapse at once into the parent form, as our artificial varieties mostly do the moment we relax the stringent regimen under which they have been produced.

XXII.

DOG-ROSE AND BRAMBLES.

It always seems as though summer had positively come in earnest when one pulls the first scented dog-rose of the season by the wayside. And here at last on the footpath through the Vicarage grounds, hedged in on either hand by clambering brambles and sweetbriar, the wild roses of every sort are really all in full bloom after a very summer-like fashion. It is a quaint and pretty old English trick of language that assigns the less useful or beautiful kinds of each rudely grouped family to the lower animals. The violets without a perfume are dog-violets; the chestnut that we cannot eat is horse-chestnut; the common parsnip of the fields is cow-parsnip. It is the same with cat-mint, dog's-mercury, horse-radish, toad-flax, and swine's-cress; while buck-wheat and buck-beans point back to an older state of things, when deer were far more familiar beasts than now in English woodlands. Fool's-parsley puts the same idea in a more practical and literal light. But who can first have called so beautiful a flower as this blushing pink blossom I am holding in my hand by such a name as dog-rose? Dogs, I know experimentally, care nothing for the scent of flowers; and the dog-rose is the sweetest

in scent of all our English wild roses. Was it merely by way of distinction from the garden rose that it got its name, or was it to mark it off from the rarer sweetbriar, whose leaves are protectively dotted with little rusty-coloured glands, which give out a delicious aromatic perfume when rubbed between the fingers? I hardly know which explanation is the more likely: for the common double rose of our gardens, which is probably a distorted variety of the French wild rose from the Mediterranean region, with its central stamens overfed into irregular and supernumerary petals, has certainly been grown for ornament since a very early period in English flower-beds. From that South European stock we get our cabbage-rose and our moss-roses; the China roses descend from an Asiatic species; while the dear old-fashioned Scotch roses, too often turned out of our gardens now by the new-fangled oriental varieties, are cultivated forms of the little burnet rose, that grows abundantly in sandy districts on our own western seaboard. All of them, however, will produce hybrids readily with one another, and with various newer Asiatic or American kinds: and it is selected varieties of these hybrids that make up the mass of our modern over-civilised garden strains.

Indeed, people generally have very little idea how many distinct species of plants or animals exist in each great group, or how absolutely they all merge into each other for the most part by insensible gradations. It is the inadequate recognition of such facts that makes us less able to realise the steps by which species change from form to form as circumstances demand of them. Almost all the most familiar animals happen to be very distinct

from one another, and from all the wild animals inhabiting Europe; and this gives us a false idea to start with of the stability of species. There is no danger of mistaking a horse for a donkey, or a sheep for a cow. But then we too often forget that these animals are purposely bred as true as possible to an artificial standard; while all intermediate links with other kinds have been killed off the soil—in civilised countries at least—by the spread of tillage. On the other hand, when, as in the case of rabbits, dogs, and pigeons, we have produced an immense variety of artificial forms, they are generally connected so closely with one another by recent descent that they all breed easily together; and we forget their differences as lop-ears or blacks, terriers or greyhounds, runts or pouters, in their common points as rabbits, dogs, or pigeons.

It is not so, however, in the wild life of nature. There, though some few species are well marked by the dying out of intermediate forms, the difficulty in most cases is to find some effective token which will constantly disdinguish one kind of plant or animal from another. The elephant, it is true, now consists only of two obscurely marked types, Asiatic and African; because all the others of his race have died off long since: though he was once connected by the ancestors of the mammoth and the mastodon with a whole line of earlier creatures intermediate between tapirs, pigs, and horses. But the cat family are still so well represented in our midst that you can find somewhere or other every single connecting link between our own tame cats and the tiger or the lion; and most of these would probably prove fertile with one another, at least along the doubtful border-land. Those

who watch nature closely know how hard it is to draw an effective line between species anywhere; and most observers differ among themselves as to the exact spot at which, if anywhere, it can best be drawn.

Take, for example, our English wild roses and brambles here. This that I hold in my hand is a true dog-rose, with a scented pinky blossom, and with few or no glands upon the edges of its leaflets. It is the commonest English form of all; but it merges so indefinitely into the various other kinds that while Mr. Babington and Mr. Borrer made seventeen distinct species altogether, Mr. Bentham recognises only five; and other authorities distinguish seven, nine, and thirteen respectively. Here in the hedgerow grows a second sort, the field-rose, with more trailing stems, paler white flowers, and more globular fruit—besides the purely technical character that all its styles are united together into a tall projecting column, instead of issuing separately from a little vent in the calyx. Scentless, the books usually call it, too, though to me it has a distinct and pleasant perfume, fainter than the dog-rose's, but undeniably real and perceptible. This bush, however, merges by infinitesimal gradations into the true dog-rose, so that even experienced botanists of the old dogmatic type cannot always tell you to which of the two species they would verbally assign a particular specimen. Each has his own nostrum—his special point on which he relies in diagnosis; and no two of them ever agree as to what it shall be, nor can any of them give you a valid reason for preferring his private system to anybody else's.

Then, again, on the other side, the dog-rose merges

equally into the sweetbriar: for though it is usually glandless, it has often a few small glands on the edge of the leaflets to guard it from caterpillars or aphides; and these are scattered freely on the under side and the leaf-stalks as well in the more typical sweetbriars. Yet the truest sweetbriar of all is undoubtedly an artificial human product, made by selecting the best or most aromatic natural specimens and cultivating or breeding from them under the most favourable circumstances. Some botanists have divided even this into two species.

In a third direction, the dog-rose varies through its hairier varieties towards the downy rose, with a prickly fruit and a more erect bushy stem.

Lastly, the two or three shorter dwarf forms, with numerous straight slender prickles, are variously lumped together as burnet roses, or else divided into two or more distinct species, according to the taste and fancy of the observer. The names we choose to give them and the lines we choose to draw are mere matters of human convenience in nomenclature: the one patent fact which all close lookers can see for themselves is this —that throughout the whole series every single character of stem, leaf, bud, flower, fruit, or seed varies indefinitely, till the attempt really to discriminate between the types becomes practically impossible.

It is much the same with their neighbours the brambles. Here, ordinary mortals have long since distinguished two fairly marked types, because of their different berries; and when you get a difference in the berry you touch the intelligence of mankind at once in one of its tenderest and deepest susceptibilities. So these two species have acquired colloquial names as

blackberries and dewberries. But in between them an indefinite number of links exist, which can no more be separated from one another than humanity could be separated into three distinct groups of white-haired, black-haired, and red-haired people. On the other hand, the so-called blackberry bushes differ so much among themselves in less conspicuous organs that they have been sometimes divided into from six to forty species, and sometimes lumped together again into one.

In the older days of natural science our Dryasdusts fought fiercely with one another over these questions of specific identity or difference: nowadays, we are all mostly agreed that such variations must naturally occur, and that the attempt to reduce them all to artificial symmetry is as impossible as it is futile. In some cases species are well marked off from one another, because natural selection has fixed steadily upon certain very distinctive or highly important features, and has exaggerated those to an extreme degree: and then the intermediate forms soon die out, because crossing becomes impracticable, and the central stock has ceased to exist. In other cases species merge imperceptibly into one another: so that all one can do is to accept certain approximate types as standards of reference, and consider the intermediate forms as neutral specimens; because the central form still holds its own, and the various lateral types, slightly favoured by natural selection in different directions, still remain capable of crossing with one another—at least on their respective borders. To this latter class such plants as the roses and the brambles belong—as, indeed, do by far the larger number of our native wild flowers. Indefinite variability

and indeterminate boundaries are indeed the rule; definiteness and distinctness of limitation are but rare exceptions. The primrose fades away into the oxlip, and the oxlip into the cowslip: till at last even the bucolic inquirer is forced to take refuge in the fundamental doctrine of Hegelianism, and admit that after all in nature every A is also a not-A.

XXIII.

SUNDEW AND BUTTERWORT.

SHOWERY August weather, with gleams of sunshine interspersed, is just what the little blue butterwort best loves: and coming out into the patch of bog above the Home Fields to look for it this morning, I find its strange spurred flowers out by dozens, among the mossy bits where the undrained pools lie thick with red rusty sediment between the tufted grassy islets, and the peat yields like a saturated sponge beneath one's hesitating feet. There is nothing wilder and more natural left in England than these frequent oases of marshy ground, dotted about through the great sheet of artificially drained and cultivated farm-land that covers the plain or the hillside; and here alone one might compile a special calendar from spring to autumn—a chronicle which should note from day to day the budding of the rushes and the sedges, the flowering of the flags and feather-foils, the fruiting of bog-asphodels and great osmunda ferns. Everywhere else, save on a few lonely moors or heaths and barren mountain-tops, our true native flora has been mostly killed off before the spread of tillage and the steady march of those cultivated weeds which came to us first from Western Asia, and which are now

making the tour of the world with English seed-wheat and English clover. We can hardly say, indeed, what the real English flowers of the plains were originally like; for some of them must now be quite extinct, and others must have grown weedier and coarser to suit the new circumstances brought about by extended cultivation. But here on the peaty hillside hollows, and in the unreclaimed bogs, bits of which may be found almost everywhere, a totally different type of vegetation still abundantly survives. Reedy tussocks of cotton-grass and bog-rush rise in little islands from the level turf; and in between them the shallow water stagnates and reddens in the hollows with the iron-mould of decaying leaves and skeleton club-moss. These lower bits, beside the trickling rills that slowly drain off the overflow from the pools, are the favourite haunts of sundew and butterwort; and what gives them their special interest to the rural mind is this—that here, side by side in treacherous friendship, grow the two most ruthless and marvellous among our English insect-eating plants.

Sundew, perhaps, is the best known to the world at large of the two uncanny things, by name at any rate; if for no other reason, at least on account of Mr. Swinburne's exquisite and musical lines: the only entire poem, I fancy, which he has ever devoted to any single natural object; for, in spite of his vague pantheistic nature-worship, man, not nature, is the real centre round which the eddy of his thoughts revolves. Here you have an entire plant, lifted, root and all, from its moist bed—as curious a herb to look at as any in the world; and indeed it is no wonder that so fantastic a creature should have been the one weed to attract in passing our

wierdest poet's special attention. The leaves are round and long-stalked, pressed flat in a tuft or rosette against the ground, and rather red than green externally even at a first casual glance. But when you look closer, you see that the actual blade itself is more or less faintly greenish, and that the redness of its surface is due to a number of living and moveable viscid hairs, each consisting of a long neck, capped by a little globular crimson gland as big as a pinhead. Some of the leaves have folded over their edges or rolled in upon themselves ; and if you open them you will find in the centre two or three decaying carcasses of flies. Whenever the insect lights upon the blade, attracted by the bright red glands with their honey-like secretion, he gets clogged at once by the sticky hairs, and cannot drag himself away from the corrosive acid for all his frantic efforts. For my own part, I cannot watch the poor creature struggling to free his legs and wings from this horrible, impassive, blood-sucking plant without at once assisting him out of his trouble ; for my instincts will not allow me to appraise the 'divine dexterity' of nature in causing destruction so highly as some of our idealistic humanitarians have done ; it is impossible not to feel a little thrill of horror at this battle between the sentient and the insentient, where the insentient always wins—this combination of seeming cunning and apparent hunger for blood on the part of a rooted, inanimate plant against a breathing, flying, conscious insect. But with a little bit of raw beef one can see the whole process just as well, and far less cruelly ; for after all, man shrinks from seeing what unconscious nature does not shrink from designing with minute prevision and care.

As soon as the fragment of meat is placed upon the leaf, the clubbed ends of the glandular tentacles hold it fast by their sticky secretion, and the other tentacles around bend over to enclose it, exactly as the arms of a polyp sweep together to catch their floating prey. If you put a dead innutritious object on the blade, the glands bend over at first, but shortly relax again ; when the object is a living fly, however, they clasp it tightly, and the more it struggles the more it excites the surrounding tentacles to close over it and hem it in securely. There it is gradually dissolved and digested, its juices going to supply the plant with materials for the production of its flower and seed.

The butterwort is a less savagely insectivorous creature than the sundew ; yet its taste for fresh meat is almost as indubitable as that of its cruel red-leaved neighbour. Its foliage is pale hoary green, covered with little crystalline-looking white dots, which produce an abundant viscid fluid, easily drawn out into long threads by the touch of a finger. When an insect lights upon it, his legs are clogged by the fluid ; and the edge of the leaf then curls slowly inward, so as to push him into the centre of the blade, where the digestive power seems to be strongest. But what is most interesting of all about the butterwort is the fact that it is peculiarly adapted for attracting insects from two distinct points of view—for food, and as fertilisers. While it lays itself out to catch and eat miscellaneous small flies with its gummy leaves, it also lays itself out to allure bees with its comparatively large and handsome blue mask-shaped flowers. It has a deep spur behind each blossom, which secretes a big drop of clear honey : while its irregular

shape is fitted neatly to the bee's body, its stamens are placed in the right position to brush against his back as he enters the tube, and its lip is covered with long club-shaped hairs among which his bristly legs can get a firm and convenient foothold. It is strange thus to see one and the same plant bidding for the attentions of one insect race by honest allurements of honey and colour, while at the same time it spreads a deadly trap for a second race with sticky glands and dissolvent acid secretions.

Why should these two totally distinct plants, living together in precisely similar circumstances, have acquired this curious and uncanny habit of catching and devouring live flies? Clearly, there must be some good reason for the practice: the more so as all other insect-eating plants—Venus's fly-traps, side-saddle flowers, pitcher-plants, bladderworts, and so forth—are invariably denizens of damp watery places, rooting as a rule in moist moss or decaying loose vegetation. Now, in such situations it is difficult or impossible for them to obtain those materials from the soil which are usually supplied by constant relays of animal manure; and under such circumstances, where the roots have no access to decaying animal matter, those plants would flourish best which most utilised every scrap of such matter that happened to fall upon their open leaves. At first, we may feel pretty sure, the leaves would only catch dead flies which accidentally dropped upon their surface: or they might begin by being descended from slightly viscid ancestors, which had acquired their stickiness to prevent ants and other intruders from climbing up the stalk—an explanation especially probable in the

case of the sundew, seeing that its parent form was almost certainly a saxifrage like the common little London pride; and these saxifrages are all noticeable for their very sticky glandular stems and dotted leaves. If any such plant, growing in peaty spots, occasionally by mere accident caught flies, which decayed on the surface of its leaves and so supplied it with a little stock of manure, it would benefit by the habit thus initiated; and natural selection would tend to increase and specialise that habit in the future. So there would slowly be evolved the long glandular tentacles, followed by the actual development of a true digestive absorbent system, and at last of something closely resembling a set of nerves, to enable the arms to close in immediately upon the struggling prey.

Butterwort, on the other hand, began by being a sort of distant cousin to the primroses; but having been cast into much the same sort of situation as sundew, it has acquired in the end very similar habits; while at the same time it has also specialised itself in another direction for bee-fertilisation, till its irregular blue flowers now show hardly any trace of their primrose origin save in some small points of internal structure, noticeable only to an anatomical eye. The two plants strikingly exhibit the strange results natural selection will often produce where very exceptional circumstances make the necessaries of vegetable life much more difficult to procure than in normal cases. Under such conditions, plants frequently acquire tricks of structure and movement which make them resemble conscious and intelligent animate creatures to an almost incredible degree.

XXIV.

WHITE RABBITS AND WHITE HARES.

WALKING out in the undercliff by Tom Fowler's cottage this afternoon, I have just come across a very unusual sight for an English warren. A snow-white wild rabbit has started this moment, almost from under my feet, and made straight for his burrow on the neighbouring hill-side. What is stranger still, he was a full-grown buck, apparently; and this is peculiar, because a rabbit of such a conspicuous colour is almost sure to get picked off early in his life by prowling owls or passing badgers. Indeed, that is just why wild rabbits as a rule possess their well-known greyish-brown colour. Such a colour harmonises well with the dry bracken and low stubble among which they feed: and it thus renders the animals as little conspicuous as possible to their numerous enemies, especially in the dusk of evening, which is their proper feeding time. Wild rabbits tend to vary in colour a little, just as tame ones do, though to a less degree: but the variations are dangerous to the creatures, because they betray them more readily to their keen-eyed foes. It is only where snow abounds that white rabbits or white hares are likely to possess any advantage; and

under such circumstances we do actually find a white species in our own island.

On the tops of the higher Scotch hills, in fact, there still linger on among the colder districts a few isolated colonies of a very interesting little rodent, known by a large and puzzling array of aliases—as the white hare, the varying hare, the Alpine hare, and the blue hare of Scotland. In size it stands about midway between the common hare and the rabbit; but it differs greatly from both in colour, general appearance, and instinctive habits. Throughout the summer months the blue hare is clad in a suit of tawny grey fur, with a slight admixture of longer black hairs; and as it runs, the shifting lights upon its back and sides produce a faintly bluish effect to the eye, which has gained for it perhaps the commonest among its numerous popular names. In winter, however, it changes colour, like the ptarmigan and most other sub-arctic species—becoming snow-white all over, except the very tips of its ears, which still remain a lustrous black. It does not burrow nor make a form, but shelters itself in natural crannies of the rock: in this respect agreeing rather with the more primitive and central group of rodents, and exhibiting less specialisation of instinct than either the common hare or the rabbit, which have clearly acquired more developed habits in accordance with their long practice of dwelling among the great open temperate plains most affected by man and by the hunting carnivores—dogs, wolves, ferrets, stoats, and weasels.

The interest attaching to the blue hare is somewhat akin to that which attaches to the red grouse, as involving a curious problem in geographical distribution.

But the cases may be regarded as to some extent the converse of one another; for, while the red grouse is altogether peculiar to Britain, the blue hare is found in scattered and isolated colonies over a wide extent of Europe and Asia. It turns up again, essentially the same, in the Swiss Alps, in Scandinavia, in Russian Lapland, in Siberia, and in Kamschatka. At present the Alpine and Scotch colonies at least are separated from the central mainguard of the species in the sub-arctic regions by wide intervening seas or plains, across which they are never reinforced by stray fresh arrivals of solitary individuals. The blue hare thus exhibits on the whole the permanence of species under identical conditions, as the red grouse and the willow grouse exhibit the tendency towards variability in species where the conditions have become more or less dissimilar.

We now know pretty accurately how these little isolated colonies got stranded so far apart from one another on the tops of the hillier regions or in the colder parts of the Eurasiatic continent. During the pleistocene period, before and between the recurrent glacial epochs, the ancestors of the blue hare spread over the whole central plain of Europe, which was then cold enough to suit their peculiar tastes; and their bones, essentially identical with those of the existing individuals, are found in cave deposits of pleistocene date as far south as the Swabian grottos. At that time they ranged over the chilly lowlands of Belgium, Germany, and the North Sea, in company with the reindeer, the arctic fox, the musk sheep, and the lemming, which have now been driven back again to the snow-bound regions of the north; as well as with the Alpine marmot, the chamois,

and the ibex, which at present inhabit only the higher ranges of the Alps, the Pyrenees, the Sierra Nevada, or the Caucasus. There they were hunted by the men of the earlier stone period, who used only weapons of chipped flint, unground and unpolished, and who lived for the most part in the limestone caverns now filled in by later accumulations.

As the climate grew warmer, however, after the clearing away of the ice, the temperate fauna began once more to replace the arctic or sub-arctic kinds in Britain and Germany. The cold period when these northern species ranged over the whole central belt of Europe corresponds roughly with the age of the palæolithic cave-men: with the post-glacial neolithic or prehistoric age we find a gradual and continuous retreat northward of the animals adapted to colder habitats. In the earlier neolithic days the moose and the reindeer were still found as far south as Yorkshire: by the dawn of the historical period they were extinct in England, though the Scandinavian jarls of Orkney still hunted reindeer among the straths of Caithness as late as the middle of the twelfth century. During the first period, too, both the blue hare and the common hare ranged together over the plains of England; but as time went on and the climate became milder the northern species retreated to the Scotch hills, where it found a more congenial atmosphere, leaving the southern plains and valleys entirely to the occupation of its ruddy ally. In the same way the blue hares of Germany also became extinct; and so the species was reduced to three isolated groups—one in Scotland, one in Switzerland, and one large connected body in northern Europe and Siberia.

Here for the most part the conditions remained so similar that the various animals underwent no material differentiation: though they vary slightly from place to place in the degree to which they retain the habit of turning white in winter.

In those countries where the snow lies long on the ground they keep up the change of coat as a protection against their enemies, natural selection effectually cutting off any specimen which varies toward brown or black at that season: and here the stoats also for the most part assume the white ermine dress in winter, so as to come upon them unawares. The black tips to the ears doubtless serve to guide the leverets in following their dams across the snow, without being so conspicuous as to betray the animal to its enemies from a little distance. On the other hand, in northern Siberia, where snow lies almost all the year round, the blue hare has a permanently white coat; but in southern Russia it hardly alters in hue, except on the back and sides.

The Irish hare is regarded by competent authorities as a variety of the blue hare, produced under the exceptionally favourable circumstances of a very warm insular habitat, combined with freedom from competition. In America the closely similar species—locally called the rabbit—accommodates itself in much the same way to the different zones of climate—being white in winter in the north, and yellowish-brown all the year round in the middle and southern States. In this case the two varieties mix so much in the uninterrupted land-surface between the Arctic regions and the Gulf of Mexico that they could not readily grow into distinct species. But in the case of the red grouse of Britain

and the willow grouse of Scandinavia such a change has been facilitated by absence of interbreeding ; and in the case of the Irish hare we get a similar change, now actually in course of operation. There is reason to believe that in America a glacial species has spread over the whole country, for even the southern forms undergo a slight winter change of coat : whereas in Europe the return of an exiled temperate species after the retreat of the ice has driven the glacial kind steadily northward, or isolated it among the colder heights of Scotland and Switzerland. It is worthy of observation that where the hares change colour in winter the stoats also usually assume their ermine dress, but where the hares remain of one hue throughout the year the stoats for the most part follow suit under the influence of identical conditions.

XXV.

THISTLEDOWN BLOWS.

In spite of much unseasonable rain, the corn in the Home Close still looks promising enough; and if we only get a little overdue sunshine for the ripening of the grain, we may yet save a decent harvest this critical summer. But the field is full of thistles, as it always is; and nothing one can do seems to be of much good in eradicating them. The down continually blows over from Shapwick Grange, the next farm, as it is now doing indeed at this very moment; and so long as the Shapwick people go on neglecting their Further Croft, there is no chance of our Home Close getting really clear of the troublesome intruders.

Nature, indeed, has been very prodigal to thistles; she has given them every advantage and no enemies on earth, except farmers and donkeys. Just look at such a head as this that I have cut off clean with a swish of my stick, and then consider what fraction of a chance the wheat or the wheat-growers have got against it. Each stalk supports some dozen heads of blossom at least; and each head contains a hundred separate flowers, every one of them destined to produce in due time a winged and tufted seed. The thistles are members of the great

composite family, like the daisies and the dandelions; and they have their little bells clustered together after the common composite fashion into close and compact flower-heads. If you cut the head through with your knife, longitudinally—it is difficult to tear it open because of the prickly tips to the bracts—you will see that it is made up of innumerable distinct purple florets: each with five petals united into a long deep tube, and each with a little seed-like fruit at the bottom, crowned by a ring of hairs (the future thistle-down), which are in fact the altered and modified relics of the original calyx. Even in its simplest form, the composite flower bears marks of being an extremely developed floral type; and the thistle, though relatively simple, is very far from being the simplest among the composite plants. A glance at the past history of the race will show why it now proves so persistent and noxious an enemy to us agriculturists. It is one of the most highly evolved and successful of living plants; and it pits itself against the relatively simple and sickly wheat—an artificial plant with a feeble constitution, which we ourselves have sedulously created for our own special use. The natural consequence is that if we did not give every advantage to the wheat and put every obstacle we can in the way of the thistles, they would live it down in a single decade; as European weeds are living down the native weeds of New Zealand, or as English vermin are living down the aboriginal marsupials of isolated Australia.

The primitive ancestral composite—to go no further back in its history than that—was already a very advanced sort of plant, with a number of little tubular blossoms, like miniature Canterbury bells, crowded to-

gether compactly into a clustered many-flowered head. Its petals were probably purple, and its calyx had even then assumed the form of long floating hairs to the ripe seed. But at an early stage of their life as composites, the group broke up into three minor tribes, from which are severally descended the daisies, the dandelions, and the thistles ; for under one or other of those general heads the many thousand known species may be roughly classified. The daisy tribe, as we all know, took to producing mostly yellow florets, with white or pink outer rays, to allure their special insect allies. The dandelion tribe turned all its florets throughout the entire head into long rays, like the external row in the daisies, and coloured them uniformly yellow throughout, on behalf of the little yellow-loving flies by whom its seeds are usually fertilised. But the thistles, the central tribe of all, retained more simply the original habits of the race, in that all their florets are still tubular, instead of being split out into strap-shaped rays ; while the vast majority of them keep as yet to the primitive purple tinctures of their race, which specially endear them to the higher insects. Bees are the chief fertilisers of thistle-heads ; but butterflies also frequently pay them a visit ; and in the Home Close at the present moment they are being attended by thousands of little black and red burnet moths, which prefer the long bell-shaped blossoms even to that favourite flower with them, the bird's-foot trefoil. Almost every head in the field is covered by half a dozen moths at once, all drinking nectar from the recesses of the deep long tube, and all unconsciously carrying pollen from stem to stem on their uncoiled proboscis.

But even after the thistle tribe had separated from its sister-composites of the daisy and dandelion groups, it was far from having reached the fully developed thistly type. The lower members of the tribe have no prickles, and some of them are very simple unarmed weeds indeed. The common sawwort, which abounds in copses and hangers in the south of England, represents the first rough draft of a thistle in this nascent condition. To look at, it is very thistle-like indeed, especially in its purple flower heads, closely surrounded by a set of tight but not prickly bracts. Living, as it does, in bushy places, however, where cattle seldom penetrate, it has not felt the need of protective defences; and so it has not been ousted from its own special haunts by the later and more highly developed true thistles, which are by origin weeds of the open grass-clad lowlands, evolved under stress of damage from herbivorous animals. But where cows and horses abound, or still earlier where deer and antelopes are common, the defenceless sawwort would have little chance; and under such circumstances only the harder and stringier plants, or those which showed some tendency to produce protective spines and bristles, could hope for success in the struggle for existence. Thus there has arisen a natural tendency in the level plains to favour all weeds so protected; and as a matter of fact the vast majority of open lowland weeds at the present day do actually possess some protective device of stings, harsh hairs, prickles, or spines, or else are very stringy or very nauseous to the taste. Our object as cultivators is generally to keep down these natively well-endowed races, in favour of the softer grasses and clovers, which

we are obliged artificially to fence in and protect with all possible precautions. But even so, in spite of all our endeavours to expel nature with our civilised pitchfork, 'tamen usque recurrit.'

The thistle that is overrunning the Home Close ranks, indeed, among the best adapted and most successful of its kind: which is only the converse way of saying that it is a most troublesome and ineradicable weed. Creeping-thistle, we call it, from its peculiar habits: for, besides its open mode of propagation by its floating seeds, it has a sneaking trick of spreading underground by its buried rootstock, which sends up fresh stems every year from the joints or nodes. It is the commonest of all its race—not in England only, but throughout the globe; for its winged fruits have been carried to every quarter of the world with seed-corn and clovers. Cut it down, and a new head springs from below the wound; hack it close to the ground, and the rootstock pushes out a fresh young shoot from an unsuspected corner; harrow it up bodily, and the seed blows over at harvest-time from all the surrounding fields, just at the right moment for the autumn ploughing.

For hardiness of constitution it has no equal; and this is partly due, no doubt, to the fact that universal cross-fertilisation has become absolutely certain by the separation of the sexes on different plants. This globular head that I have just swished off has none but stamen-bearing florets; this other more conical cluster, that I am trying to cut with the aid of my knife and handkerchief, contains nothing, on the contrary, but pistils and seeds. Such careful separation of the two elements perfectly ensures a good cross in each generation, and so

greatly improves the quality of the strain. Add that every stem produces some thirty or forty heads, each containing more than a hundred florets, with winged seeds that fly about everywhere, and can you wonder that thistles are so plentiful? Even the less developed types, like the melancholy thistle of the Highlands—so called from its gracefully nodding or drooping head—get on well enough, though that particular species differs from all others in not being prickly, and depends for its defence entirely on its stringy nature. Centaury and corn-bluebottle, too, are others of the same tribe, which have differentiated themselves in less unpleasant ways than the true thistles; while the common burdock has turned the prickles on its head into small clinging hooks, which help to disperse the seeds in a somewhat different manner, by clinging to the legs of animals: and it is a significant fact that the burdocks are most essentially wayside weeds of the waste places in cultivated lands. But in its own particular group—that is to say, among the purple central composites—the creeping thistle in the Home Close is certainly the highest existing product of vegetable evolution; and that is what makes me bestow upon it, after all, a certain extorted meed of grudging admiration. It lays itself out to be troublesome, and it succeeds to perfection.

XXVI.

SCARLET GERANIUMS.

We have such a show of many-coloured pelargoniums in our little cottage-garden at this moment as would put to shame, I verily believe, any modern bedded-out parterre in all England. For, indeed, I will frankly confess to an old-fashioned love for natural old-fashioned flowers, undistorted by the florist's art; instead of those stiff, overgrown, unsymmetrical bosses of irregular leaves which nursery-gardeners nowadays display with so much pride to admiring connoisseurs as splendid double varieties. The doubling is, of course, produced, for the most part, by converting the central stamens into shapeless petals, and so destroying the native symmetry and architectural ground-plan of the original flower. If you look into a real natural blossom, you see in it always a definite and beautiful scheme, which centres on the truly essential parts—the stamens and pistils: but if you look into a double rose, or, still worse, a double geranium, you see nothing but a confused mass of wrinkled and amorphous petals, without any distinct central point or any consistent harmony of plan. It may be true, as Polixenes says to Perdita, that though 'this is an art which does mend nature,' yet 'nature is made better by no mean,

but nature makes that mean : ' still, she makes it merely, as it seems to me, by way of disease or disorganisation ; and I go rather with Perdita (as Shakespeare himself clearly did) in declaring ' I'll not put the dibble in the earth to set one slip of them.' No : our cottage garden does well enough with the old hardy perennials and annuals, the mints and marjoram, the daffodils and violets, the lilies and oxlips of our English poetry ; it will not away with your modern gloxinias and echeverias, and heaven only knows what other new-fangled things, called by doubtfully classical names unlovelier than themselves.

Among all our old-fashioned garden flowers, not one is brighter or prettier than these common pelargoniums from the Cape which we all know familiarly as scarlet geraniums. They are not exactly of the genuine botanical geranium type, it is true ; but they are quite near enough to it for even unlearned eyes to perceive immediately the close relationship between them. I suppose everybody knows the little wild herb-robert of our English roadsides—its pretty lace-like foliage turns so bright a red on dry walls or sandy hedge-banks, that even the most casual passer-by can hardly fail to have learned its name. Herb-robert is the true geranium ; and it has many familiar allies in Britain and in the rest of Europe, including that large and brilliant kind the blood geranium which stars the limestone rocks of the Mediterranean and the Atlantic shores, from Sorrento and Cadiz to our own Cornish, Welsh, and Cumbrian cliffs.

The ordinary scarlet garden pelargonium is descended from a very similar type ; and yet though it is so

common and so well known a plant, it has some strange peculiarities of structure which escape the notice of ninety-nine out of a hundred among those who have seen it familiarly in their gardens or their vases from childhood upward. Pick a truss of the bright red blossoms from the plant—we have no despotic gardener here to frown at us for meddling with our own belongings—and then nip off a single flower from the head, close to the point where the clustered bundle joins the main stem. Perhaps you have never observed before that the single flower-stalks are each slightly humpbacked: there is a sort of knob on the stalk about a quarter of an inch above the junction with the stem; and from that knob upward the stalk grows twice as thick as below. Again, look at the flower full in front, and you will observe, what perhaps has hitherto escaped your notice, that all five petals are not equal and similar, but that the blossom is bilateral instead of radially symmetrical; it has two upper petals distinctly different in shape from the three lower ones. The upper pair are narrower, and stand on rather long claws; the lower trio are broader, and have no claw. Now, pull off the two upper petals, and you will see that behind them there lies a deep pouch or tube, running along the top of the flower-stalk as far as the knob. Cut the stalk across, and you will find it hollow on the top; cut it down lengthwise, and, if you follow up the pouch throughout its whole length, you will learn that it leads at last to a drop of honey, secreted in the furthest recesses of the knob. To put it shortly, what seems the flower-stalk is really a stalk and a nectar-bearing spur run into one. How this has happened, and why it has happened, one can easily understand by the

analogy of this other old-fashioned garden flower, the common nasturtium or Indian cress.

In the nasturtium, you see at once that the upper lobe of the calyx is prolonged behind into a deep and pointed spur; and you have probably bitten off one of these spurs at some time or other and have found that it contained a large supply of rather pungent but very luscious honey. At least, it seems pungent to our clumsy taste, because we have to cut or bruise the tissues of the plant in order to get at it. Now, if you bend back the spur of the nasturtium so as to make it touch the flower-stalk, you have artificially imitated the arrangement in the scarlet geranium; only that in the geranium the two parts have actually coalesced, for a reason which I shall try to explain a little later. First, however, let us see how the scarlet pelargonium itself got developed out of a primitive ancestor, something like our own little pink herb-robert. A technical book of botany will tell you, after its dogmatic fashion, that the genus geranium is distinguished from the genus pelargonium by these marks or differentiating peculiarities: the geraniums have regular flowers, ten stamens, and five honey-bearing glands on the disk, and they are natives of almost all temperate climates, northern or southern; the pelargoniums have irregular flowers, with two upper petals different from the remainder, a spurred honey-bearing pouch to the calyx, no glands on the disk, and only about five stamens instead of ten, and they are confined (in their wild state) to the Cape of Good Hope and a few neighbouring regions.

Now all these facts are very significant: they show that the pelargoniums are a highly evolved and special-

ised race, produced under peculiar circumstances in a limited tract of country. We know that the competition between flowers for the visits of fertilising insects is particularly fierce in South Africa : because from no other district do we get so large a number of our most conspicuous garden blossoms ; and wherever such strong competition exists, as among the higher Alps and in the Arctic regions, where bees are almost unknown, and butterflies are rare, only the most brilliant and attractive flowers of all succeed in getting fertilised. Under these circumstances, the native geraniums of South Africa have been compelled to specialise themselves into the highly peculiar pelargonium form : or, to put it more correctly, only those which did so have ultimately survived.

Instead of having five honey-glands on an open disk, which any small insects could easily thieve, the pelargoniums have secreted all their honey in one depression, which has grown longer and longer till at length it has assumed the shape of a deep pouch. This, on the one hand, has made it accessible only to insects with a very long proboscis ; while, on the other hand, it has simultaneously enabled the flower to make more sure of proper fertilisation, and so to dispense with half its original complement of stamens. The sensitive surface of the pistil now turns down to meet the pollen on the insect's head, as it poises on level wings before the deep nectary ; and this surface itself consists of five spreading fingers, covered (under a slight magnifying power) with beautiful crystalline glands to which the pollen readily adheres. The irregularity in the petals follows as a guide to the insect ; the upper pair being slightly raised on

claws in order to let him get more easily at the mouth of the tube. In the common scarlet species all the petals are coloured much alike: but in these rarer kinds that grow by its side the irregularity is much more marked; for the lower three are uniform in hue, while the upper pair are striped with darker lines, which lead straight to the opening of the nectary, thus acting as regular honey-guides.

Much the same thing happens in the nasturtium; which, however, is far more remotely allied to the true geraniums, and which probably arrived at its own similar arrangement by a distinct line of evolution. Whether the honey-tube of the pelargonium was once separate from the stalk, as that of the nasturtium still is, and whether it afterwards coalesced with it, it would be difficult to decide. Certainly there would be a slight gain in the latter plan, as I have often seen humble-bees unable to get at the honey of the nasturtium in a lawful fashion owing to the length of the tube (which is not well adapted to any British insect), feloniously appropriate it by biting through the side—in which case, of course, they cannot benefit the plant, as they do not touch the pollen or fertilise the seeds; while I have never observed anything of the sort happen in a pelargonium, where the honey is much better concealed. It is more likely, however, that the spur in this last instance has really grown out of a slight depression along the footstalk; and, if so, it can never have been a single separate organ.

XXVII.

RAIN ON THE ROOT CROPS.

HERE in the country we are really beginning at last to lose heart altogether. Night after night we see the leaden mists gathering ominously over Pilbury-hill; and morning after morning we see a fallacious gleam of sunshine or two peeping through the lattice at five o'clock, only to find the whole sky overcast again and heavy showers pattering steadily against the window-panes an hour before breakfast-time. Never was there such a diluvial summer. Sometimes for a couple of days at once we get a little respite, with nothing more serious than occasional downpours from a passing white fleece that drifts island-like before the wind through a sea of blue; and then the deceptive barometer struggles slowly upward with every promise of settled weather. But just as the mercury and our spirits rise half-way to 30, another squadron of black rain-clouds comes careering to us across the Atlantic, till the glass and the farmer's heart sink down together gloomily to 'very stormy.'

To-day is just as bad as any of its predecessors. It is now a full month since we carried our hay in the lower croft, and still to this moment we have not been able to put a scythe into the high meadow on the top of War-

down : nor do I see any chance of mowing up there as long as those big dark shadows continue to chase one another with such cruelly heedless merriment across the broad sloping flank of Pilbury. The corn in the Home Close ought now to be filling out in ear under a genial flood of sunshine ; instead of which, constant rain is turning the field into a fine crop of golden charlock : while as to the turnips, they bid fair soon to afford excellent cover for wild duck, which could be most conveniently and satisfactorily shot, American fashion, from a shallow punt along the furrows. In such weather as this it is good to be a philosopher ; and one may at least reflect with pleasure that crops which are spoilt for all practical purposes are still quite good enough to philosophise upon.

Indeed, from the biological point of view, even the rain is not without a certain mournful interest of its own. Turnips differ very little in their origin from charlock ; and there is nothing on earth that charlock loves so much as a wet summer. But, then, charlock is not anxious for fresh material to store up in its root-stock for the flowering season, like the swedes and turnips. The difference all lies in the fact that the weed is an annual, while the plant from which we get our cultivated roots has been practically converted under our hands into a sort of irregular biennial. There is a wonderfully close similarity between almost all these cabbage-like plants in the wild state, and they illustrate beautifully the natural limitations of man's selective agency in producing artificial varieties. Charlock is a capital typical example of the race ; for it is perhaps one of the simplest and earliest forms now surviving, and

the least differentiated in any one special direction. It is not a true native, but comes to us, like so many other weeds of cultivation, from those South European lands through which most of our fruits and cereals passed on their westward way from Central Asia.

Now, in charlock there is no natural quality which makes it worth man's while to subject it to tillage or artificial selection. Its leaves are rough, coarse, and hairy, so it will not serve for the basis of a potherb ; its stem is hard and stringy, so it will not serve for the basis of a succulent vegetable like sea-kale or asparagus ; its seeds are small and ill supplied with starches or food-stuffs, so it will not serve for the basis of a grain or pulse ; its root is harsh, and rapidly tapering into numerous subdivisions, so it will not serve for the basis of a swede or a turnip. Even its flowers, though gay and bright enough, are too straggling and fugacious to make them worth cultivating for ornamental purposes ; while its fibres are not fine or long enough to twist into a good rope ; and therefore the charlock is probably condemned to remain to the end of its existence nothing more than a mere field weed, hated by all farmers, and rooted out mercilessly as a dangerous competitor to the pampered corn crops.

Most of the cabbage tribe present, on the whole, very much the same general characteristics ; and there are, accordingly, certain fixed limitations in their possible uses which can seldom or never be overcome. So far as I know, not a single one of the cabbages, or of the whole crucifer tribe to which they belong, ever yields an edible seed ; and in this they contrast strongly with the grasses and the pea-flowers, which supply us with almost

all our principal grains and food-stuffs. The reason is that the crucifers have never learned to lay up a separate store of albumen beside the seed-leaves of their embryo, nor even to fill the seed-leaves themselves with starches to maintain the young plant in the earlier stages of its struggling existence. On the other hand, those cabbage-worts which deviate slightly from the central charlock type may be utilised in certain other ways, in accordance with the nature of the deviation. Here, for example, growing on the edge of the turnip-field, is the undoubted wild ancestor of the turnips themselves—the meadow navew. Its leaves are still rough and hairy, so we can do little with them in the way of greens, though when young and tender they are not unpleasant, with their slightly bitter spinach flavour : but its root is larger and rounder than that of the charlock ; and here the primitive husbandman shrewdly saw his practical chance of an edible vegetable. By neglecting leaves or seeds, and selecting the most favourable variations in the root, he at last succeeded in producing a modified turnip, from which later agriculturists have again developed the still larger, coarser, and rounder swedes. Moreover, though the seeds are but small and poor, they contain a considerable proportion of oil ; and by concentrating attention on this peculiarity, to the neglect of all others, we have managed also to evolve independently from the same parent stock another variety, the rape-seed, from which we express colza oil. Each of these plants remains exactly alike in foliage and flowers, because we have expended no selective action upon those points ; but in the parts on which selection has been definitely exercised they differ widely from one another, and from

the parent wild navew whose peculiarities already contained them all potentially in the germ. To this day, either turnips or beets which 'break,' as we call it—that is to say, which flower at the natural period—become small and shrunken ; because the original store of food-stuffs was laid by in the root for the flowering season ; and when the blossoms come out the plant has practically reverted to its primitive condition. Similarly with the cabbage : we have here adopted a closely related variety—one can hardly call it a species, the two are so much alike—with smooth thickish foliage and a perennial stock ; and while its flowers, roots, and seeds remain unaltered, we have diverted its leaves into a solid head, and produced from them the various cabbages and curly kales of our gardeners. On the other hand, when we choose to fix ourselves upon the blossoms alone, we can make (or rather continuously select) a diseased form with overfed abortive buds, which gives us from the self-same stock our cauliflowers and broccoli. So one can readily see why the rain which suits the narrow fibrous rootlets of the charlock, and does not hurt even the simple wild navew, rots and destroys the big artificially plimmed-out tap-root of our cultivated turnips.

The other crucifers less closely related to the true cabbages exemplify the same principle even more widely, and cast much interesting side-light on the strong and weak points of the analogy between man's conscious selective action and the unconscious preference of nature for the best adapted varieties. Scurvy-grass is a crucifer somewhat more advanced in type than the cabbage-worts, in that its flowers are white instead of yellow ; and from one of its more distant south-eastern relatives

we have adopted our own horse-radish, whose pungent root, favoured and preserved in the natural order of things because of the protection it afforded the plant against gnawing animals, has been utilised by ourselves for the sake of its value as a relish in small quantities to our more jaded palates. In the water-cress and other cresses, which are also members of the same group, we are similarly attracted by the very essences which were meant to deter the animate creation; though in this case we ourselves do not care for them except when the plants are very young and tender. Sea-kale, again, is a maritime Devonshire weed, introduced into our gardens during the last century; and here the portion of the plant we eat consists of the succulent shoots which force their way up through the sand in spring, and which we intentionally lengthen out and blanch by the device of artificial banking. Gardeners say that it flourishes best even now when surrounded by its natural element—sand from the sea-shore. The origin of our radish is not known with certainty, though it probably represents an improved southern variety of the jointed charlock that grows by road-sides in many parts of England.

All these are purely useful variations on the one primitive theme; but there are some other crucifers whose flowers have been developed into a higher state of perfection by insect selection, and many of these supply us with a groundwork for ornamental garden blossoms. Simplest among them are the little white alyssum, with its sweet honey perfume, and the queer one-sided candy-tufts of old-fashioned gardens, whose two outer petals have grown longer and broader than the two inner ones, so as to present a larger total attractive surface, thus

clearly bearing witness on their very faces to the intervention of insect agency. Even higher in this respect are the stocks and gillyflowers, whose petals are raised on long claws, so as to form a tube for the preservation of the honey from minor flies and beetles. These and a vast number of other garden plants or wild weeds are all shown by their common points of structure to be descended from a single original ancestor ; and the peculiarities which natural selection has stamped upon them have in many cases been further developed or exaggerated by the action of man. In fact, it would almost seem as though we had but to set an ideal before our eyes, and then by constant selection to bring it about bodily in the sphere of concrete reality. On the other hand, wherever the natural tendencies exist, we may produce very like effects in the most widely different families. Thus the carrot does not belong to the same group as the turnips at all, but is a similar highly evolved root of the extremely unlike parsley and chervil tribe ; while the beet and mangel-wurzel are equally remote by ancestry, being artificial products from the goosefoot and spinach line of descent.

XXVIII.

HOPS BLOSSOM.

How infinitely various and wonderful is Nature! Every day her chronicler has something fresh to relate, and every day he has to make his choice between a thousand equal and conflicting claims. To-day the bees are at their annual massacre of the drones; and as I passed the hive I saw them busy at that unnatural orgy which leaves human noyades and fusillades far behind in ingrained ferocity, were it only by its measured and instinctive character. To-day the first teasel of the season opens its buds, and the insects by the orchard are all agog accordingly, crowding with an inquiring proboscis around the serried bayonets that guard its heads of bloom. To-day the fleabane expands its rays; to-day the water-plantain bursts into pinky-white blossom by the river-side; to-day the wild clematis begins to drape the hedgerow with its long festoons of clustered flowers. To-day, too, we get the first distant reminder of coming autumn; for I see the oats are beginning to mellow; and the swifts, far earliest of our migratory birds to wing their way southward, have already deserted their nests under the eaves of the church, where, like ardent ecclesiologists that they are, they love best to fix their

summer quarters. They left us but yesterday, and by this time they are doubtless calmly taking a bird's-eye view of affairs at Alexandria. But, perhaps, of all the events that mark this morning in the rural calendar, the most practically important to man is the blossoming of the hops. Passing the bines on my way down to the river—trout are rising well in the shade this week—I notice that the young cones have now just opened, and that the little green flowers are now fully expanded in good time for an early harvest. The fly that threatened such evil things a few weeks ago disappeared suddenly with the wet weather; and now, if all goes well, the hops at least may prove a successful vintage amid all the failures of this disastrous year. With fine weather in future, we may perhaps hope to begin picking by the last days of August.

No plant grown for economical purposes is more graceful and beautiful in its mode of growth than the hop. It stands alone among the nettle tribe in its twining habit: and, indeed, it has diverged so widely from all the rest of its kin, in pursuance of this abnormal trick, that it now occupies a special genus all to itself; in other words, it has broken so completely with its ancestral type that no intermediate links at present remain to connect it directly with its nearest congeners. Nothing could be more unlike at first sight than a lissom creeper such as the hop, and a stiff erect roadside weed such as the stinging-nettle. Yet both are immediately descended, at no great distance of time, from a single common progenitor; and both retain in a very marked degree all the most distinctive features of underlying structure which they inherit together from their similar

ancestry. The flowers are almost identical in hops and nettles, as well as in their yet humbler ally the pellitory—Solomon's 'hyssop that springeth out of the wall,' whose English name is a mere corruption of *parietaria*, just as pilgrim is of *peregrinus*. In all three the male and female blossoms are distinct. In all three they consist, among the males at least, of four or five green leaflets, enclosing an equal number of elastic stamens. Contrary to the usual rule in flowers, the stamens are arranged opposite to the calyx scales, instead of alternately with them—a fact which shows that a row of petals, once intermediate between stamens and calyx, has been suppressed by disuse, owing to the acquisition by the flowers of the habit of wind-fertilisation. For, normally speaking, all the successive rows in flowers are arranged alternately with one another, as anybody may see in a moment by looking at a fuchsia or a strawberry blossom; but when the petals are lost through change of habit the other whorls appear to stand opposite to one another, though the real nature of their arrangement is always preserved for us in intermediate forms, with very small petals, which are occasionally entirely wanting. By these and numerous other minute agreements in points of structure, the nettles, hops, and pellitories are all seen to be descendants of a single common ancestor, which had already lost its petals and had separated its sexes in different flowers, but had not yet, of course, acquired any of the special characteristics that mark off the nettles, the hops, and the pellitories from one another.

On the other hand, the hop itself must very early have begun its own special differentiation from this old central generalised form; or else it would not now

exhibit so many points of minute adaptation to its own peculiar habitat, nor would it be so distinctly marked off from its other divergent relatives on either side. While all of the nettles are mere soft herbs, and most of the pellitories are slightly shrubby weeds, the hop has acquired the habit of producing a stout perennial root-stock; from which each spring it sends up wonderfully long annual stems, that climb to an immense height over the poles in cultivation or over bushes and thickets in the wild state, dying down again entirely with the approach of winter. I know nothing more marvellous in the way of growth than the rapidity with which these lithe bines curl spirally up the bare poles in early summer—at first on the strength of material laid by in their buried root-stocks, but afterwards by the rapid assimilation of aërial food from the surrounding atmosphere. As one watches the slender young sprays and the graceful five-lobed heart-shaped leaves, rendered so singularly like those of the wholly unconnected grape-vine by exact similarity of situation and function, one can almost see them with the eye of scientific faith drinking in the carbon visibly from the air around by the numerous thirsty pores on their under surface.

Everything here has been obviously designed for the climbing habit. The rough hairs which in the nettle serve as glandular reservoirs for a deterrent poison are transformed in the hop, by a thickening of their base, into recurved prickles, which serve as hooks to aid the plant in hanging to the poles, or rather, in the wild state, in clambering over small trees and hedgerows: for of course the original evolving bines could never have contemplated their descendants' future domestication in

Kentish hop-gardens. If you run your finger and thumb upwards along the branches or young sprays, against the grain, you will find that these prickles cut like a rasp ; while if you look at a wild hop festooning a hedge, in free luxuriance, in and out among the equally prickly goose-grasses and other climbers, you will recognise at once that the hooks have been developed by natural selection for the same purpose as the tendrils of the vine and the pea, or as the little sucker-like rootlets of the ivy. Every climbing plant must needs possess some such means of clinging to its chosen support ; and the particular means it happens in each case to develop will depend entirely upon the nature of its organisation before it began to acquire the twining habit. In the vine and the pea, tendrils readily grew out of branches or leaf-stalks ; in the hop and the goose-grass, hooks were more easily produced out of pre-existent hairs and asperities still retained in their original form by other descendants of the common ancestor.

It is the flowers of the hop, however, that give it its chief interest in the eyes of bibulous humanity ; and the flowering mechanism is the part of its organisation in which the plant most widely departs from the norma of its race. On the specialisation of this part, in fact, it has expended its chief attention. In pellitory a few of the blossoms still remain hermaphrodite, with stamens and ovaries in the same flower ; in most of the nettles all the blossoms are separately either male or female, though both kinds grow together on the same plant ; but in the hop, as in the commonest stinging-nettle, the two kinds of flowers are altogether divided, each individual bine bearing on its clusters only one sort or the other. The

staminiferous blossoms are of small practical interest: they consist simply of these inconspicuous little yellowish-green panicles, hanging from the angles of the upper leaves in this wild creeper, and looking very much like their near relations the nettle flowers. Still, they keep up something like the semblance of a floral pattern, having each five small green sepals and five curved stamens enclosed in their midst. The female flowers, however, which grow at last into what we know as hops, have become so degraded or so highly developed, whichever you choose to call it, that their true nature is now hardly recognisable at all. Their little florets are closely crowded together in globular heads, looking much like a miniature green pine-cone; and under each bract of the cone two minute flowers are packed away carefully in a corner, with their calyx reduced to a tiny protective scale, and the rest of their architecture simplified down to a single ovary enclosing one spirally coiled seed. It is the central floral idea reduced to its simplest possible factors. From the scales the sensitive surface protrudes to catch the pollen blown to it in the wild state from the male on its feathery arms; and then the fertilised cone begins to swell, and the bracts grow out into large inflated cups, quite concealing the small seed-like fruit. Whether their bitterness has been acquired as a deterrent to animal enemies it would be hard to say: certainly, it has not availed to protect them against man, who from time immemorial has employed the hops to flavour the insipid drink which he prepares from malted grain, 'in quandam vini similitudinem corruptum,' as Tacitus puts it, with *naïve* southern contemptuousness for the barbaric stimulant. Certainly, no other plant has been so little

transformed under the hands of man ; for, except so far as the mode of its cultivation goes, it is still essentially the same species in the Kentish hop-gardens as it is when it climbs at its own free will over the hedges and thickets of South-western England.

XXIX.

THE DEPARTURE OF THE SWIFTS.

THE earliest among all our summer migrants to leave us for warmer autumn quarters are those large, dark, rapid swallows, known best to country people as black martins or jack-screamers, but to which ornithologists have given the very appropriate name of swifts. They come in spring a week or ten days later than their congeners—about the 25th of April in an average year—and they are all gone again by the first week in August, only a very rare straggler being ever seen in England after the middle of the month. Even in Southern Europe they do not linger into September. No other bird—except their ally, the humming-bird—is so ceaselessly active on its wings as the swift. Popular science (or what once passed for such) has told the same story about it as about the bird of paradise: that it had no feet, and so was compelled to keep for ever on the wing—except when in its nest; and the fable has even been enshrined by more rigid biologists in its systematic name of *Cypselus apus*. On early summer evenings you may see the swifts skimming the surface of still pools on their broad wings, catching the May-flies and dragon-flies that hover above the edge, and sometimes just dipping below the level in

their curved sweep to take a flying sip from the water as they go. Their monotonous shrill scream never ceases for a moment meanwhile ; for the swift appears to be all nerve and muscle—a sort of miniature engine for perpetual motion, self-feeding and self-governing, but using up all its powers from minute to minute, till at last it runs down incontinently from sheer wearing out of the unwearied vital mechanism.

I often fancy that time to the swift must seem far fuller, and therefore far longer, than it seems to us. An hour must be so crammed with fresh impressions and ever-varying emotions in those quickly pulsating little brains, that it must lengthen out subjectively to the apparent dimensions of a human month. Shelley once finely said, in one of those luminous philosophic moments which make him at times more than a mere poet in the purely artistic sense, that if an infinity of thought could be crowded into a minute, that minute would be eternity. Now, if one reflects that the swifts which are among broad English oaks to-day will be among the laden vineyards of Andalusia to-morrow, and among the palm-groves and mosques of Algeria the next day—not cooped up by the road in narrow covered boxes, but winging their way freely with their own wide pinions, and looking down with unobstructed gaze upon all the intervening seas and mountains as they pass—one can understand that perhaps to them that wild sense of exuberance and richness in feeling which balloonists always tell us they experience in the upper air may be the regular and habitual experience of these little birds' aërial life.

And not only must each moment be always full for them of constantly shifting impressions ; but their

nervous organism itself must be attuned for a more hurried flow of consciousness than is possible with our sluggish human brain and muscles. The rapid movements of wing and breast in the swift imply and necessitate a rapid action of the heart, a rapid circulation of the blood, a rapid inhalation and exhalation in the lungs. In a given time the swift moves more, breathes more, and therefore probably feels and lives more, than any other known animal. Of course the quality of its thinking need not be at all high, judged by a human standard; but the quality of its vitality, the extent to which it lives its life, must apparently be very high indeed. For a quick flow of warm blood through the brain means on the subjective side a vast total wave of consciousness, sensory or emotional; and it also probably means a very rapid succession of ideas, however simple, a relatively quicker perception of external objects, and a relatively faster adjustment of muscular movement to the movements of surrounding things. Any one who watches the swifts wheeling and curvetting over the water, or darting with unerring swoop at flies which seem themselves to dart faster than a human eye can follow, need hardly doubt that to their simple little minds a second is an appreciable interval of time, during which there is room enough to form an idea, to make a muscular co-ordination, and to carry the desired movement out in fact.

Nor need we even suppose that the action of the swift is like the action of a cricketer catching a ball off the bat, where the muscular adjustments are made with an unconscious celerity and accuracy which sometimes appear surprising even to the actor himself; for the

cricketer is performing an exceptional and remarkable act, a *tour de force* of co-ordination in its own way; whereas the swift is only doing what all its race habitually do and have done for countless generations. It is impossible not to admit that there are real differences in the apparent value of time to different nervous organisations. The wing of a gnat beats many thousand separate beats in a minute; and each beat, though doubtless purely automatic, still implies for its motor-power a distinct nervous impulse. The swift is far less rapid in its movements than that; but then each movement of the swift is almost certainly conscious and voluntary. We can hardly doubt that if clock-hands and fly-wheels were both alive, a minute would seem a much longer division of time to the fly-wheel than to the clock-hand. It has been well said that in acute mania the nervous organism is burning itself out too fast: what is morbid in the lunatic is normal and healthy in such a bird as the swift.

Swifts eat on the wing, drink on the wing, and collect materials for their nest on the wing. Hence, like all other very active creatures, they produce extremely small broods; for the material used up in muscular motion cannot also be devoted to genesis as well. The nests are usually rude unshapely structures, under the eaves of churches or among the ruins of old buildings generally; and only two eggs are usually laid by each mother in a single season. It would be a curious question what these haunters of old buildings did for a home before the days of civilised man; for I have never known them build away from human habitations or churches. Perhaps the species in its present form may

really date later than civilisation, as one may suspect of many other creatures, both weeds and house parasites, like geckos and crickets: for after all, even civilisation is old enough to have exercised some minor transforming influence upon the outer shapes of organic beings, as it undoubtedly has upon their habits and instincts.

Long ago, Gilbert White was much puzzled with the difficulty, suggested to him by the swifts, as to what became of the annual increase which must take place even among such small breeders as these; for though they lay but two eggs at a time, and sit but once each summer, instead of twice like the other swallows, yet that must give a constant increment of population at the rate of about double every year, even after allowing for normal deaths of old birds. What becomes of such increase? That was the question that puzzled the naturalist of Selborne; and if he had been a Darwin, or even a Malthus, it might have led him gradually on to the great discovery of the principle of natural selection which has since revolutionised all biological science. As it was, he came only to the lame and impotent conclusion that they must disperse themselves over the remainder of the world: as though Selborne church-tower were the central Ararat of an unpeopled and vacant continent, whence endless colonies might go forth to increase and multiply and replenish the earth. In sober fact, one half of them fail to pick up a living at all; the other half just keep up the standard of the race to its fixed numerical average: for everybody who has watched the swifts closely knows that each year just the same number of pairs return punctually to just the same accustomed stations in just the same ancestral towers.

Indeed, that is the rule with the vast majority of species, animal or vegetable. There are a few which, like man, the Colorado beetle, and the Canadian pond-weed, are rapidly increasing and overrunning the world; there are a few others which, like the great auk, the beaver, and the edelweiss, are rapidly dying out before their enemies. But by far the greater number seem to continue absolutely invariable from year to year, at least within the range of ordinary human observation. Out of 40,000 seeds of one common English weed, only a single seed on an average produces a full-grown plant every season.

CHAPTER XXX.

WATERSIDE WEEDS.

At the extreme lower end of the farm, where the three-cornered croft adjoins Smallcombe Barton, our little brooklet Venlake broadens out for fifty yards or so into a shallow cattle-pond, covered on its surface with bright-green fronds of floating duckweed, and bordered at the edge by a lush margin of rank sedges and tall black-crested reed-mace. The vegetation of this valley pool is quite different in type from the sundews and butter-worts of the upland bogs, and yet it is almost equally wild and beautiful in character after its own special fashion. Comparisons, indeed, are never more odious than in the matter of natural scenery. The other day, when I was wandering among the tufted cotton-grasses and pretty orange bog-asphodels of the marshy patch on the common, I said in my haste that there was nothing in England so native and graceful in its beauty as that exquisite flora of the peaty upland ; to-day as I stand by this little pool of Venlake—a mere water-logged corner trodden down apparently by the heifers coming constantly to drink where the bank stands lowest—I feel as though I must go back upon my own words, and give the first place for gracefulness among English plants to the waterside flags and upright cat's-tails. See, here

by the little rapids where the beck tumbles by miniature cascades into the pond, the aromatic sweet-gale grows in unwonted profusion : smallest of our native catkin-bearing trees (except the dwarf creeping willows), it loves the neighbourhood of running water, where its little thickset bushes rise to a height of two or three feet only, and its clusters of tiny nuts, dotted with little balls of resin like beads of amber, overhang the petty brink with their fragrant bunches. Crush the shiny foliage between your fingers, and it yields at once a grateful country perfume, redolent of the wholesome resin in its dotted leaves. Here, too, are tall bur-reeds, with their globular heads of greenish flowers ; and here are great graceful white-blossomed arrowheads ; and here are the lolling heart-shaped leaves of the floating pond-weed ; and here again are the tall black reeds, looking like natural maces, with their thick black heads and their waving summit of ragged fluffy cotton, standing sentinel in long rows over the shorter vegetation in their shadow beneath.

The truth is, our ordinary taste in the matter of flowers, and especially of wild flowers, is still a trifle barbaric. The first thing that strikes children or savages in flowers is their brightly coloured petals ; they care little for beauty of shape in blossoms, for gracefulness and delicacy of outline in foliage, for the glossy leaves of the holly or the hartstongue, for the infinite variety that custom cannot stale in the crisped and wrinkled fronds of ferns. When they pick a nosegay, it is all bright blossoms without a touch of relieving verdure : the only thing they care for is the crude staring red and blue of the largest petals. Accordingly, all the earliest

flowers to be selected for cultivation were the biggest and brightest in hue—the roses, pæonies, sunflowers, and hollyhocks. It is only very lately that we have begun also to choose some plants for their foliage or their general effect; to grow purple-leaved coleuses, quaintly lop-sided begonias, and crimson-hearted caladiums in our greenhouses; to pleach out pampas-grass, and weeping willows, and feathery deodars with artful carelessness on our lawns and shrubberies; to cover the naked crannies of our poor imitation rock-work with the dainty tracery of ferns and club-mosses. Even now, we have not paid sufficient attention to the ornamental value of the common wind-fertilised plants. They have no gay petals to attract us, like their insect-haunted allies; they do not strike the eye at once in the dappled meadows, like the buttercups, the fritillaries, the clematis, and the wild daffodils; yet they have a wonderful indescribable grace and beauty of their own, which nobody can fail to appreciate, at least when once attention has been consciously directed to their more modest and retiring shapes. Their flowers usually either hang out loosely in long waving panicles, like the grasses and sedges, or else cluster closely together in curious globular or cylindrical heads, like the reeds and the catkins. It is to this class that most of the waterside weeds in England belong: and they share with all other wind-fertilised plants not only the common gracefulness of habit, but also the common marks of degradation or degeneracy from higher and more conspicuous petal-bearing ancestors.

Look first at the floating pond-weed here, with its delicate leaves just basking on the surface of the pool,

the older ones of a rich glossy green as they spread along the water's top, the younger ones not yet unrolled and of a pale chocolate brown or fawn-colour in the half-opened bud. From the centre, a spike of little greenish flowers projects above the level of the water, as plain and unnoteworthy an inflorescence, I must admit, as anybody could wish to see. Yet even here the plant as a whole is made beautiful by its heart-shaped floating foliage, by the long thin transparent sheaths that guard its stem, and by the singularly lovely colour of its unopened leaves. And if you look closely at the separate flowers themselves, you will see that they each bear obvious marks of their ultimate derivation from bright petal-bearing progenitors in their possession of four little green scales surrounding their stamens, the last stunted relic of their original coloured corolla. This is a case where degradation has only gone, comparatively speaking, a very little way. We can still see on the face of the flower the rudiments of its former petals, though all their function is now lost.

Turn next to the bur-reed here, this much-branched bushy-looking succulent plant whose long lance-like leaves closely overhang the shallow edge of the pool. Its flowers look at first sight like mere round knobs or balls, stuck quaintly on to the side of the thick juicy branches, and decreasing in size towards the ends of the green twigs, from the diameter of a whiteheart cherry to that of a small pea. But when you come to look more closely into them, you can see that they are of two kinds, the larger and lower ones consisting of little pointed nuts, all crowded together in a dense globe ; the smaller and upper ones composed of clustered stamens, irregu-

larly interspersed with a few casual green scales. Nothing can well be prettier than the various stages of the female or nut-bearing heads, from the time when they first appear as close bundles of pearly knobs till the time when they finally assume the ripe shape of prickly defensive capsules. Each tiny flower in these heads still retains a slight rudiment of its lost petals in the shape of three or six little scales surrounding its ovary; but in the male flowers, the scales disappear almost entirely, or survive only as irregular or obsolescent organs scattered up and down among the stamens of the densely packed head. The more thickly the blossoms are clustered, the more are the now useless relics of the petals crowded out between their really serviceable organs.

And now if we turn to the cat's-tails or reed-maces that grow hard by out of the water itself, we can see the same process carried to the furthest possible extreme of degradation. I suppose everybody knows them by some name or other, as black-cap rushes or something of the sort—those great smooth round stems, four or five feet high, surmounted by a thick woolly looking black cylinder by way of a head. In reality, this cylinder is an immense mass of such wind-fertilised flowers, crowded together literally by myriads along a dense spike on the stem. The top part, which grows fluffy and withers after a short time, consists of the male blossoms, here reduced to naked stamens only, with a few inconspicuous hairs scattered among them to represent the scales that once were petals. The lower part, which becomes thicker and longer as the autumn wears away, consists of the female flowers, reduced to very minute ovaries, each surrounded by a bundle of small hairs, which similarly stand for the

three or six green scales of the female bur-reed. Each ovary is now so extremely small that you cannot distinguish them separately at all with the naked eye: if you cut the spike across, the only thing you can see is a thick mass of soft brownish hairs, black at the tips and paler inside towards the central stalk.

How many hundreds of thousands of flowers are thus cribbed and cabined on a single stem nobody has ever had the patience to count; a mere pinch pulled out between the finger and thumb displays under the microscope an apparently infinite number of distinct florets, each with a single tiny ovary and a fluffy envelope of small hairs. Yet all this degradation, as we rightly account it, is strictly in adaptation to the peculiar habits of the reed-mace. It grows by the edge of shallow waters only; and since these are very liable to dry up or shift their place from time to time, it requires great numbers of easily dispersed seeds, so as to take advantage of every new habitat which petty topographical changes may put at its disposal. Hence wind-fertilisation and winged fruits exactly suit its special needs; and in adaptation to those needs it has become, perhaps, the most degraded type of flowering plant now in existence, save only the little floating stalkless duck-weed which forms a green film on the surface of the half-stagnant water at its base.

CHAPTER XXXI.

ASPARAGUS BERRIES.

MOST English lilies flower in spring or very early summer; but asparagus is an exception to the general rule, for it does not come into full blossom before the middle of July, and I see the big green berries are now only just beginning to redden on the sunny side under two weeks of the cloudless skies of August. The world at large hardly knows asparagus at all, except as a succulent spring vegetable; and that one-sided point of view doubtless makes it rather difficult for most people to recognise in it any traces whatever of the lily family. Yet a genuine lily it really is for all that; and if you look attentively at these graceful feathery sprays of clustered foliage (they make capital decorations in a specimen vase with summer blossoms), or at these little drooping yellowish-green bell-flowers that hang pensile here and there along the branches, you will see that the lily type is present in all essentials, and that only the prepossessions of the epicure element could ever have prevented one from recognising its true affinities at the first glance. The blossoms, in fact, hang down not unlike Solomon's seal, only that they are composed of separate greenish petals, instead of having a single

tubular corolla ; and they are pretty enough in their own unobtrusive way, though not nearly so striking as the beautiful bright red berries which succeed them a little later on in autumn. Asparagus is a wild plant of the British south coast by origin ; and though it is now becoming rather rare on our own shores, I have still picked a few sprigs of late years on the rocky islets at Kynance Cove in Cornwall, and at some other isolated places along the English seaboard from Devonshire to Wales. Its life-history is a curious and an interesting one, for it forms a rare example in our own country of a green leafless plant, with branches closely simulating foliage both in appearance and function.

The primitive wild asparagus is a wiry herb with a matted perennial rootstock, in which it stores up food-stuffs during each summer for the supply of its succulent green shoots in the succeeding spring. Under tillage we have made it increase from its primitive stature of two feet or less to an average height of four or five ; and at the same time its spring shoots, which are slender and rather stringy in its native sands, have grown much stouter and softer under stress of continuous selection directed to this single end alone. But in order to make it send up vigorous grass (as gardeners call it) at the return of spring, we are obliged to let it grow tall and bushy during the whole summer, so as to elaborate plenty of rich materials, including its essential flavouring principle asparagine, in the creeping root-stock from which next year's sprouts will draw their whole supply of food. That is why, though we finished cutting in June, the bushes must still go on cumbering the earth till they die down naturally on the approach

of autumn. If we hacked it down at present we should have no asparagus to speak of next season.

Now, everybody has noticed that the young shoots which form the eatable part of asparagus are covered by small pointed purplish scales; and these scales are, in fact, almost the only true leaves that the plant ever puts forth in its present condition. But as it grows older it begins to branch off into numerous sprays to right and left; and these sprays are covered with clusters of feathery green spikes, closely resembling foliage, and not at all unlike the needles of firs and some other conifers. In reality, however, these apparent leaves are abortive flower-stalks; while the only true leaves on the branches are some very small and almost microscopical scales around the point where the needles diverge from the stem that bears them. It is true the little wiry branches do all the work that real leaves ought to do: they are quite green, and they act as digesters of carbon from the air for the plant; so that it seems at first sight a hard saying to be told that they are at bottom only flower-stalks. Yet so certain is that curious fact, that even long before evolution was dreamt of, all technical botanists had fully made up their minds that the apparent leaves of asparagus and its allies must be theoretically described as 'abortive pedicels.' And this is probably the way that such a strange freak of nature first came about.

Asparagus is a simple species of lily which has taken (in its wild state) to growing in very dry and sandy soils. Now, the lily type of leaf, as we all know, is a long thin succulent blade, extremely ill-adapted for dry or sandy places. Hence all the lilies which are

driven by circumstances to take up their abode in such spots have been forced to get rid of their own real leaves, and to develop some other distinct organ into a serviceable foliar substitute in their place. If they did not do so, they died out entirely, and there was an end of them: only those which happened to accommodate themselves to their environment in this particular succeeded in finally surviving; and amongst such survivors are the asparagus bushes of the present day.

How such changes began to take place we can better understand if we look for a moment at the analogous case of the butcher's broom which grows instead of box in the little hedge here by the shrubbery. Butcher's broom is another aberrant lily, and a very close ally of the asparagus tribe; but it shows us the same peculiarities in a rather less marked and advanced degree. I suppose everybody knows its stiff prickly leaves, with a small white six-petalled flower apparently growing out of the very centre of each leaf. In this case it is easier to realise that the seeming leaves are really altered branches—first because we can actually see the flowers still budding out of their midst; and, secondly, because if we look close we can observe a minute scale, which is the rudiment of a true leaf, springing from their midrib just below the point where the flowers are given off. Careful examination, in fact, shows us that the branch has become flattened and leaf-like, but that it still retains all the essential characters of a branch: because it bears flowers and true leaves, whereas, of course, nobody ever saw one true leaf growing right out of the back of another. It is worthy of notice, too, that, in order to protect the flowers from injury, each seeming

leaf twists at the stalk, and so turns its upper surface downward to the ground. In time the female flowers grow into brilliant scarlet berries, which look as if they were gummed on to the lower side of the leaves ; and these berries contain a couple of little hard-shelled nutlets, which are dispersed by the assistance of birds, as in most other similar cases.

Now, in butcher's broom, almost all these leaf-like branches still bear flowers and berries on the mid-rib of their expanded surface ; but there are a good many barren branches on each bush, which act as leaves pure and simple ; while a few scales beneath each such branch represent the original flat blades of the primitive lily ancestor. In asparagus, the same process has been carried just one step further. The young spring shoots here bear flat mauve scales, not unlike in shape to an abortive grass-blade ; but on the upper branches these scales become very small and inconspicuous indeed, while from their angles there project a number of long needle-like green points, which form the practical working foliage of the plant at the present day. Every here and there, three or four of them bear a little drooping greenish lily-flower each at their summit, especially near the lower end of each branchlet ; but by far the greater number spring in little clusters of four or five together from the axil of a scaly leaf, without any flowers at all at their pointed ends. They are, in fact, abortive flower-stalks, like the barren branches on the butcher's broom : only in this case the vast majority of flower-stalks are thus abortive, and only a very small number devote themselves to their proper function of producing blossoms.

It must not be imagined, however, that the asparagus once passed through the butcher's broom stage: the resemblance between the two plants is rather analogical than strictly genetic. Both, doubtless, are ultimately descended from simple typical lily ancestors, which had suffered dwarfing of the true leaves through their enforced restriction to dry habitats; and with both only those individuals have finally survived which happened to diverge in directions adapted to their new mode of life. The butcher's broom has made its way by developing stiff, prickly, and expanded branches, whose broad green wings do duty instead of leaves: the asparagus has attained the same end by producing vast numbers of small thread-like flower-stalks, only a small proportion of which ever actually bear perfect flowers. But so far as its blossom is concerned, the asparagus stands nearer to the prime ancestor than does the butcher's broom: for it still possesses three distinct calyx-pieces and three petals; whereas in its ally all six parts have long since grown quite indistinguishable; and in the minor details of the stamens and pistil the asparagus also retains more markedly than its ally the common ancestral traits. Hence we cannot say that one form has been actually derived from the other: both are rather divergent descendants of a single central ancestor, whose peculiarities each has modified in a different direction.

CHAPTER XXXII.

THE KERNING OF THE WHEAT.

A NARROW single-file pathway leads obliquely as a short cut across the lower corn-field to the bridge, and on either hand the mellowing corn rises sharply beside it like a wall, with its tall shocks now just turning from pale green to golden brown before the ripening sun and the warping wind. As I pass through it I cannot avoid trampling down a haulm or two of the overhanging straw here and there, so closely does the crop encroach upon the track that threads among it. There are bright yellow corn-marigolds scattered in between the heads, and great scarlet poppies by the edge, and dark blue-bottles further afield, and lilac scabiouses overtopping even the tallest beards. Beneath, too, there is an interloping mat of smaller weeds: lithe climbing buckwheat or black bindweed, with its barbed and heart-shaped leaves exactly mimicking the lesser convolvulus, whose funnel-like blossoms open by its side; stiff wiry knot-grass forming here and there a ragged undersward; creeping toadflax pressing tight to the ground its broad leaves and snap-dragon flowers; red bartsia sucking out the life-blood of the corn with its parasitic rootlets and clinging suckers. For even the most carefully tended

wheat-fields are always more or less thickly choked with those innumerable weeds of cultivation which no tillage can ever eradicate : hardy Asiatic straylings whose seeds have followed the grains and pulses over Europe and America, and whose constitution successfully defies every attempt to kill them down by fair means or foul. The more you uproot them or burn them or sift their seeds, the more pertinacious are those which still survive : for by picking out the more conspicuous you only leave the more insidious to spread and multiply ; and by cutting off the roots from the sicklier you only leave the stronger to send up fresh suckers and runners from their wounded stocks. Yet, in spite of hard competition, and all this wealth of intermingled weed, the corn now looks far better than one could reasonably have hoped a week or two ago ; and the shocks have filled out bravely for the most part under the late fine weather : though there are really many empty spikelets, I fear, on most of the heads—mere barren chaff, with no grain inside it. Even in the field we have already cut there will be no certainty as to the actual yield until we begin the regular autumn threshing.

The sample spikes that I have picked from beside the path and roughly husked by rolling them between my palms seem to promise a fairly large harvest in this particular patch of corn-land. The grains are large and full, and the number of fertile spikelets on each head is pretty well up to the average. Few things are sweeter than fresh wheat, chewed till it is reduced to the condition of gluten ; and I suppose it must have been some such chance trial on the part of some early savage that first suggested the notion of cultivating the wild goat-grass

which became the ancestor of all our modern wheat. A hungry hunter, no doubt, coming home unsuccessfully from stalking the antelopes with his flint-tipped arrows, rubbed between his dusky hands some of the grasses that grew on the open plain around him, and extracted from their chaffy scales a few insignificant but sweet little seeds. The original parents of all our cereals were grasses of one kind or other, often belonging to remotely different groups, but almost all indigenous inhabitants of the Central Asian and Mediterranean regions. The millets of India have been developed from wild species closely resembling certain rare English grasses found only in the southern counties; the wild barleys grow abundantly in many parts of Britain; and the wild oat, which flourishes in every district of England, is certainly the ancestor of our cultivated oats. But the pedigree of wheat, the most important of all our cereals, is a little more obscure: it has varied to a greater degree from its humble original than any other known artificial plant. Fortunately, we are still able to recover the steps by which it has been developed from what might at first sight appear to be a very unlikely and ill-endowed ancestor indeed.

The English couch-grass which often proves such a troublesome weed in our own country is represented around the Mediterranean shores by an allied genus of annual plants known as goat-grass; and one of these weedy goat-grasses has now been shown with great probability to be the wild form of our cultivated wheat. It is a small dwarfish grass, with very petty seeds, and not nearly so full a spike as the cereals of agriculture; but it was long ago remarked as closely allied to true wheat,

in all essential structural points; and by constant tillage and selection it has again been made of late years to develop rapidly into a form not unlike that of the poorest and earliest cultivated wheats. Of course, it cannot be expected that experiments, however skilful, spread over a few years only, would succeed in producing from the wild stock grains equal to those which have been produced by countless generations of unconscious or semi-conscious selection on the part of primæval tillers. Still, enough has been done to show that even a short course of carefully directed tillage will transform the Mediterranean goat-grass into a fair imitation of the wheat grown by our earliest agricultural ancestors.

How soon in the history of man the goat-grass began to be deliberately sown in little plots of ground around the huts of evolving savages we can now hardly guess; certainly there remain no existing traces of its use by the very first race which inhabited Europe—the palæolithic hunters who chased the mammoth and the woolly rhinoceros among the jungles of Abbeville or by the glacier-bound terraces of the Thames Valley. But when man first reappears in northern Europe, after the great ice-sheets once more cleared away from the face of the land, we find him growing and using a rude form of wheat from the earliest moment of his re-establishment in the desolated plains. Among the pile-villages of the Swiss lakes, which were inhabited by men of the newer stone age, we find side by side with the polished flint axes and the hand-made pottery of the period several cereals raised by the lake-dwellers on the neighbouring mainland. The charred seeds and water-logged shocks disinterred from the ruins of the villages include

millet, barley, and several other grains; but by far the commonest among them is a peculiar small form of wheat, which has been named scientifically after the ancient folk by whom it was used.

This lake-wheat, however, though it dates back to the very beginning of the recent period in Europe, cannot be considered as the first variety developed from the primitive goat-grass by the earliest cultivators; it is so superior in character to the wild stock that it must already have undergone a long course of tillage and selection in more genial climates, and must have been brought back to Europe in a comparatively perfect condition by the short dark people who settled our continent immediately after the termination of the glacial era. While the ice-sheet still spread over the face of England, as it now spreads over the face of Greenland, the ancestors of the neolithic people must have been slowly improving the breed of wheat somewhere among the recesses of the central Asian plateau; and by the time the northern peninsulas and islands became once more habitable, they must have returned to the vacant lands, bringing with them the seeds of their goat-grass, now advanced to the condition of the small lake-wheat. This gulf has again been nearly bridged over for us by the direct experiments conducted of late years in France and at Cirencester.

From the neolithic time forward, the improved seed has continued to grow bigger and bigger, both in the size of the shocks and in the girth of the individual grains, until the present day. The original small lake-wheat, indeed, lingered on in use in Switzerland and the north down to the days of the Roman conquest; but

meanwhile, in Egypt and the south, still better varieties were being gradually developed by careful selection; and we find both kinds side by side in some few instances; thus showing that both were grown together at the same time by races in different stages of civilisation. With the introduction of these better kinds by the Greek and Roman colonists into Gaul and Britain, the old lake-wheat became quite extinct. Indeed, in every case the cultivated seeds and fruits which grew in neolithic garden plots were much smaller than those of our own time: whereas the wild seeds and wild fruits found under the same circumstances are just as large as their congeners of the present day. In other words, while circumstances have not since compelled any increase of size in the wild plants, constant selection has produced a great increase in the cultivated varieties. It must not, however, be inferred that no changes whatever have since come over the wild kinds in any respect: as in all other cases, there has been change and modification in minor matters proportionate to the lapse of time which has since intervened. But a lapse which makes relatively little difference to the stable wild weeds makes relatively great differences in the very plastic and carefully selected cultivated plants.

XXXIII.

THE ORIGIN OF GROUSE.

A HAMPER of grouse from a friend in Scotland has a double interest, biological and culinary. I shall hand over the four even brace to the cook for further operations; and I shall dissect the odd bird as an ornithological study. The common red grouse of the Scotch moors indeed may be considered in one particular as the most interesting living group of British birds. They form at present the only species of higher vertebrates entirely peculiar to these islands. We have, it is true, several local species of British trout, found only in certain small pools or mountain tarns of Wales, Scotland, or Ireland; but beside the red grouse we have no indigenous bird, mammal, reptile, or amphibian wholly peculiar to our own country. This fact gives a very singular interest to the grouse, and naturally suggests the question, whence did it come to us?

As a whole, there can be no doubt that the mass of our existing British fauna and flora is North European, and that it reached our shores in the interval between the last glacial period and the final insulation of Great Britain and Ireland. It is now universally acknowledged by biologists and geologists that after the great

ice-sheet finally cleared off the face of England, our islands formed for some considerable time an outlying peninsula of the European continent, like Spain or Scandinavia at the present day; and over the broad bridge of land which then occupied the bed of the German Ocean and the Irish Sea, the plants and animals of temperate Europe spread by slow degrees across the unoccupied plains and valleys of the British Isles. Their onward course over the land denuded by the ice-sheet was undoubtedly very tardy, for many species never succeeded in reaching England at all; while others, which got as far as our own island, did not travel as much to the west as Ireland before the submergence of St. George's Channel made that part of Britain into a separate island. It is, perhaps, to this accident of position, rather than to the exterminating efforts of St. Patrick, that Ireland owes its famous freedom from the presence of many terrestrial reptiles and amphibians. A little later, before the advanced guard of the European mammalia had fully occupied our eastern coasts, the North Sea and the Straits of Dover were invaded by arms of the Atlantic, and Great Britain finally assumed its insular shape. Thus our existing fauna and flora really represent a mere fraction of the Central European species—the few pioneer kinds that had travelled so far on their way into the bare waste before the sea cut us off from the remainder of the European world. We are comparatively rich in insects, birds, bats, and plants, whose wings, eggs, or seeds give them special opportunities of transport across the sea; but we are very poor indeed in terrestrial mammals and land-amphibians, which cannot readily

be transported across wide stretches of intervening water.

Mr. Wallace has noticed that in all such insulated lands there is a great tendency for species to vary, partly through the special sets of circumstances to which they are thus exposed, and partly through the rarity of crosses with the original stock, which doubtless continues to develop and alter on its own part in another direction, under pressure of other influences to which it is exposed in the wider continents where it dwells. In Britain, though so recently separated from the mainland, as Mr. Wallace points out, this tendency has already produced a few very marked effects. An immense number of our native plants appear in slightly different varieties from those of the mainland; and in our outlying islands, such as Man, Wight, Lundy, Arran, and the Hebrides, such variation is exceptionally common. Among insects we have several British species; among fish we have six or seven kinds of trout; and among birds we have the grouse, which is quite unknown in any other part of the world. Its nearest Continental representative is the willow-grouse of Scandinavia, which ranges all round the northern hemisphere even up to the Pole. But the willow-grouse changes its coat to white in winter, like the ptarmigan, whereas the Scotch red grouse keeps its summer dress the whole year round: and many minor points of difference have caused our own bird to be universally ranked by naturalists as a good species. Ought we really to regard it as the primitive type from which the Continental bird is derived, or ought we rather to consider it as a special insular descendant of the willow-grouse, or ought we finally to look upon both

as divergent lateral branches from a single original common stock? Probably the last, and for these reasons.

The bird which came northward at the close of the glacial period, to inhabit the now thawed plains of northern Europe, much as the American partridge might take possession of Greenland if all its glaciers were to clear away in a more genial era, was doubtless a more or less southern and temperate type of grouse-kind. Coming into Britain, it would soon be entirely isolated from all its allies elsewhere; for it is of course a poor flyer for distance, and it inhabits only the northerly or westerly parts of our island which lie furthest from the Continent, separated from Holland and Scandinavia by a wide sea. Here it could not fail to be subjected to special conditions, differing greatly from those of the European mainland, partly in the equable insular climate, partly in the nature of the vegetation, and partly in the absence of many mammalian foes or competitors. These conditions would be likely first to affect the colouring and marking of the feathers, the spots on the bill, the naked scarlet patch about the eye, and so forth: for we know that even freer-flying birds in the south, which cross often with Continental varieties, tend slightly to vary in such ornamental points; and a very isolated group like the red grouse would be far more likely to vary in similar directions. Meanwhile, the main branch of the family, separated on the great continents from this slightly divergent group, would probably acquire the habit of changing its plumage in winter among the snows of the north, by stress of natural selection, just as the Arctic fox and so many

other northern animals have done ; for in a uniform white surface any variation of colour is far more certain to be spotted and cut off than in a many-coloured and diversified environment. Thus it would seem probable that the Scotch grouse has slowly become accommodated to the heather, among which it is so hard to discover it ; while the willow-grouse has grown to resemble the snow in winter, and the barer grounds of its northern feeding-places in the short Scandinavian and Icelandic summer.

If this be so, we must regard both birds as slightly divergent descendants of a common ancestor, from which, however, our grouse has varied less than its Continental congener. Of course, it is just possible that the common ancestor had already acquired the habit of changing its coat in winter before the divergence took place ; and if so, then it is the Scotch grouse which has altered most : but this is less probable, because the usefulness of the change would certainly be felt even in a Scotch winter, and the white suit is not, therefore, likely ever to have been lost when once acquired. Though the winter is not severe enough in Scotland to make such a change of coat inevitable where it does not already exist, it is yet quite severe enough to preserve the habit in animals which have once acquired it, as we see in the case of the varying hare, a creature which in colder ages spread over the whole of northern Europe, and which still holds its own among the chillier portions of the Scotch Highlands. Hence we may reasonably infer that if our grouse had ever possessed a winter coat it would have always retained it for an alternative dress, as the ptarmigan still does in the self-same latitudes. Accordingly, analogy seems to point to the conclusion

that the Scotch grouse is a truly native breed, slightly altered by the conditions of its insular habitat from a closely allied Continental species, whose representatives elsewhere have now all assumed the guise of Scandinavian willow-grouse. In other words, the two isolated groups into which the species has split up have altered each in its own way, but the Continental variety has moved faster away from the primitive type than its British congeners.

XXXIV.

PLUMS RIPEN.

THE blue plums in the garden have now acquired their ripe purple bloom, and their cousins the sloes on the blackthorn bushes in the copse are fast softening to such sour pulpiness as their wild nature ever permits them. In outer look the plum-tree and the sloe-bush do not present any very close resemblance; yet the one is really the cultivated offspring of the other, and their history is consequently the same throughout—at least until we arrive at its penultimate chapter, with the first domestication, so to speak, of the eastern sloes by man. Plums and sloes are roses by family, descended from original creeping ancestors not unlike the wild strawberry plant, only without its peculiar juicy and succulent fruit. A long course of unrecorded development in the progenitors of the plum kind has made their stems grow constantly woodier and woodier, by numerous stages which we can still roughly trace through every gradation of herb, shrub, bush, and tree throughout an immense collection of diverse congeners. From simple little weedy annuals, which die down entirely every winter, and are reproduced next year by seed alone, we pass on upward through perennials with

slightly woody underground stocks, sending forth fresh flowering stems with each returning spring, to small tough under-shrubs whose branches alone die down in autumn, and finally to arborescent bushes, all of whose stiffer boughs become permanently woody from the very first. And side by side with this upward evolution from the green weed to the solid tree we can trace a concomitant evolution from the many-seeded berry like the raspberry or the blackberry to the one-seeded stone-fruit like the sloe and the plum. All those members of the rose family which have reached this highest type of rose development, with shrubby or tree-like stems and one-seeded fruits, form together the almond sub-tribe of modern botanists. As in all other cases, their succulent fruit-coverings are due to the selective agency of birds and forestine animals, which aid them in dispersing their large, hard, indigestible seeds ; and the unusual size of these coverings shows at once that they belong as a class to sub-tropical and tropical regions, being adapted to large and active animal allies, as our English wild strawberries, raspberries, and blackberries are adapted to the smaller needs of northern birds.

Even among the plum or almond sub-tribe itself there are many differences of size and colour in the fruit, according to the special localities where the various trees have fixed their home. Our little black English bird-cherry is a northern and Arctic variety ; it flourishes best in Lapland and Scandinavia, becomes scarcer and scarcer as we move down into Scotland and central Europe, disappears altogether in southern England and Ireland, and only penetrates into the south European and south Asiatic regions along the snowy

chains of the Caucasus and the Himalayas. The fruit is eaten chiefly by the larger northern game-birds ; and it has never been found worthy of systematic cultivation. Our common sloe has a more southerly range and a bigger fruit ; but even it in the wild state is very sour and little relished except by our native birds. In south-eastern Europe and central Asia, however, the sloes grow larger and somewhat sweeter ; their bushes are more tree-like and not so thorny as with us ; and the whole plant approaches much nearer in appearance to the cultivated plum. This southern variety, often distinguished as a separate species, but still linked to the common northern blackthorn by infinitesimal gradations of intermediate forms, is the wild stock from which the earliest garden-plums were originally raised. Still more southern in type is the ancestral cherry, which extends in a doubtfully wild state as far north as Britain, though here it appears rather to be a seedling straggler from orchards than a truly indigenous tree. The apricot, which belongs in all essential particulars to the plum group, comes from still further south, being a denizen of Armenia by origin, developed under the influence of the great sub-tropical fruit-eaters, who feed upon it in its native woodlands. Peaches differ from plums, and especially from the transitional apricot, only in the wrinkled character of the stone—a protection apparently against the teeth of monkeys or large rodents ; and they belong originally to Persia, Afghanistan, and the neighbouring regions. Their fruit represents the highest level of size attained by the plum or almond group, though they fall far short in girth and brilliancy of the great tropical kinds produced in the regions of toucans,

hornbills, cockatoos, parrots, and other large bright-hued fruit-eaters. Even in southern countries, however, there are many small species, adapted to the smaller birds, such as the common laurel and the Portuguese laurel, both of which are true plums, with evergreen leaves to suit a milder winter climate.

Our own sloes must doubtless have branched off from the common central one-seeded stone-fruit group about the middle of the tertiary period. They are very closely allied in every respect to the cherries, which represent only a somewhat more southerly variation of the same ancestral stock. As bushes of the northern thickets, however, the sloe-trees have either acquired or retained the habit of producing short abortive pointed branches along the stems, which act as defensive thorns to prevent the attacks of the larger animals. They blossom very early in spring, before the leaves are out, for they have a comparatively large fruit to perfect before autumn in the precarious sunshine of an English summer; and besides, they have to anticipate the more attractive white-thorn, which almost monopolises the attentions of the fertilising bees in its own rather later flowering season. The material for the blossoms is already laid by in the permanent tissues of the bush, and therefore the blackthorn can flower equally well at any time, as far as resources go. But those bushes which flower earliest must always have best succeeded in alluring bees, and have fared best in setting their fruits, while later individuals could not compete with the lush-scented and thicker-blooming may, and could not always ripen their seeds before the advent of the autumn frosts. Hence the habit of early blossoming has become ingrained in the race by the constant

survival of those families which possessed it, and the constant dying-out of those families which delayed their bloom till the may was out.

With us, the sloes are small, hard, and very acrid ; but in southern Europe and central Asia, where the conditions are more favourable for the production of large and juicy fruits, they become longer, sweeter, pulpier, and less bitter ; the trees grow taller, with more of a distinct trunk ; and, as a natural consequence, they tend rather to lose the thorns, which are only serviceable to small straggling bushes, liable to be trodden under foot by cattle, deer, or antelopes. It is this southern variety that was first taken in hand by man as a garden fruit ; for almost all our common cultivated plants come to us, with the rest of our civilisation, from the central Asian and Mediterranean region. The little bullace now most nearly resembles the wild southern stock, and it has been discovered and recognised among the rubbish-heaps of the Swiss lake-villages ; so that its cultivation is at least as old as the later stone age, and probably far older, for it appears even then as a distinctly cultivated and improved variety. Still, these very ancient bullaces are considerably smaller than the smallest garden plums of the present day, as is always the case with fruits and seeds found under similar circumstances.

By dint of long selection our modern plum-trees have lost their thorns, doubtless because the thorny specimens were disagreeable to the pickers, so that any stray thornless sport would be sure to obtain a preference and be used as the chosen parent of future varieties. To be sure, the gooseberry-bush has not yet lost its prickles ; but then the gooseberry is a comparatively

recent fruit in cultivation, hardly dating back much further in time than some ten centuries, whereas the plum has been grown by man for a practically immemorial period. Under stress of tillage, the original bullace has been once more distributed into the various types of damsons, greengages, Orleans plums, and golden drops, which differ from one another in their fruit far more than the bullace itself differs from the wild sloe of southern Europe. Indeed, seeing that all these markedly distinct varieties have been demonstrably produced within quite recent times from a single common ancestor, it is not difficult to understand how that ancestor itself may have been produced at a still earlier age from the central parent stock of all the plums, apricots, and cherries. What nature thus did before by her slow selection, man has merely continued to do more rapidly by his quicker and exclusive methods. Only, man concentrates his attention on one single point alone—the succulent fruit ; nature equally favours every useful variation in stem, leaf, flower, fruit, or seed alike. Hence it happens that while the wild cherry differs slightly from the blackthorn in almost every particular, the greengage differs from the damson almost exclusively in the fruit, every other part remaining essentially identical. If cultivated plums are allowed to sow themselves and run wild at the present day, they retain their tree-like form, but revert rapidly to the bullace type. If long permitted to continue wild, however, they show a tendency at last to go back even to the parent south European blackthorn. Their acquired habits are not yet sufficiently ingrained in the race to constitute them a good and permanent species.

XXXV.

THE PEAR HARVEST.

THE orchard does not show by any means such a pretty sight now as it promised to do in the early prime of a splendid flowering season. Then, the apple-trees were draped from head to foot in a mass of rich pinky blossom, and the bees that hovered over them all day long seemed to presage a good setting of the fruit against the autumn picking. But something or other has gone wrong with the development of the fruit: the great cyclone in early summer caught the leaf-buds in the very act of unfolding, and nipped them so severely that the trees now hardly show any foliage at all on their naked straggling branches. Leaves, of course, are the mouths by which the plant drinks in fresh material from the surrounding air: for it is a great mistake to suppose that its chief nutriment is derived from the buried roots. The soil supplies water and mineral constituents to be sure; but the true food of the tree, the vegetable matter which it builds up into wood and leaf and flower and fruit, comes to it from the floating carbon and hydrogen in the air alone. So without a fair supply of foliage to assimilate this aerial nourishment it is impossible for the plant to produce large and healthy fruit; though, on the other hand, when it uses up all its

vigour in putting forth a rich crop of leaves, it has little material left for flowers or apples. The pears, however, escaped with comparatively little damage: they are earlier by ten or fifteen days than the apple-trees, and they seem to have gained strength enough meanwhile to enable them to withstand the gale better than their tenderer and later neighbours. Different trees and different varieties show very different degrees of hardihood in this matter; some kinds of pear, such as the Forelle, will resist frost just after flowering which kills every other sort; while comparatively few pippins or improved English varieties of apple can be grown at all in the latitude of Stockholm. In fact, the petty differences upon which natural selection works for the ultimate production of new species exist abundantly everywhere; and there is hardly any such difference, however minute, that will not give one variety an advantage over another in some peculiar habitat or situation.

Fundamentally, of course, apples and pears may be regarded as slightly divergent descendants of the same common ancestor. Our sour little wild crabs and hedgerow pears show us the two types in their earliest divergent form, as yet not very widely separated from one another; for their distinctive excellences have been largely brought out by cultivation, which, as in many other cases, has exaggerated their differences of set purpose, so as to produce two fruits in place of one. The rose family, that great mother of succulent fruits, which rises in one direction towards the plums and the peaches, rises in another towards the pears and apples. But the mode in which the fruity effect is here produced greatly differs in principle from the mode in which it is produced among

the plum tribe. There the solitary seed or stone, with its pulpy covering, stands out from the calyx as a separate organ in the centre of the flower : here, on the contrary, the five cells or seed-vessels which make up the core have completely coalesced with the swollen calyx, to that the latter forms the edible portion of the so-called fruit. Indeed, it is difficult to examine a pear without observing that the fleshy part really consists of a mere expansion of the stalk, with its fibres gradually lost in a mass of sweet succulent tissue. This change has been very curiously brought about by the sinking of the seed-vessels into the body of the stalk, a singular plan for ensuring safer fertilisation on the visits of bees.

The same device is found throughout all the allied members of the rose family, such as the true roses, the hawthorn, and the medlar ; but nowhere in such perfection as among the narrower pear and apple group. It has nothing in common with the method adopted by the strawberry, where the common bed of the numerous seed-cells assumes a succulent condition ; nor with that adopted by the raspberry and blackberry, where the outer coat of each seed-vessel becomes itself a juicy covering ; nor with that adopted by the plum and cherry, which is identical with the raspberry type, save that the number of pulpy seed-vessels to each blossom is reduced to one only. The immense variety of plans by which nature thus secures the same end—the dispersion of the seed by birds or mammals—shows us that whatever may be the character of the useful tendency, it will be equally encouraged and selected by survival of the fittest, irrespective of its conformity to or divergence from any fanciful ideal type.

It is fairly certain that the hawthorns, medlars, and a few other allied groups are all descended from a common ancestor with the pears and apples, and that this ancestor branched off from the main line of rose development at a very early period. All of them still retain the primitive number of five fruit-cells, which has been wholly lost in many allied types. But while the hawthorns and some of their congeners have gone on to acquire hard, bony, nut-like coverings to their seeds, the cell-walls of the pear and apple group remain simply thin and cartilaginous, making what we call a core: so that the whole fruit can be readily cut across with a knife—a peculiarity which at once distinguishes this minor tribe from all its stony-celled neighbours. The so-called wild service-tree (a complete misnomer, for the cultivated service is derived, not from this but from the mountain ash) still pretty accurately represents for us the original stock from which the higher pears and apples are derived. It is a tall shrub or small bush, common in central and southern Europe, but not often seen in England, except in the southern counties, where it grows sparingly in hangers and copses. Its small brown globular berries are apples in a very miniature form indeed. They are still occasionally sold in country markets; and they form a favourite food of small birds, by whom their pips are widely dispersed. In the shape of its leaves, as in other points, the wild service-tree may be regarded as a sort of central junction, whence the other members of the pear group have slowly diverged in different directions. For while the true roses and most other early members of the rose family have very compound leaves, composed (as everybody knows) of several little

toothed leaflets, arranged opposite one another on either side of a common leaf-stalk, the wild service-tree has broad leaves, vandyked only half-way through into a few pointed lobes: and this type marks it out at once as an intermediate stage between the very much divided foliage of the true roses and the perfectly simple elliptical foliage of the pear and the apple.

From such a central junction, then, or rather from some ancestral form closely resembling it, the primitive pear-like bushes began once more to split up under pressure of special selection into two divergent branches. One branch, clinging rather to the mountainous districts, and accommodating itself to the peculiar circumstances of its own chosen habitat, developed gradually into the rowan or mountain ash; a moderate-sized tree in sheltered uplands, a stunted shrub on wind-swept summits or at very high latitudes beside the Arctic Circle. Like most other trees of windy regions, it has its leaves divided into small opposite leaflets, to prevent them from being tattered by the storms; so that here the vandyked lobes of the wild service-tree have separated into a number of totally distinct pieces, arranged in regular rows along a central leaf-stalk. Indeed, it is a general principle of foliage that wherever means of growth fail, the leaves become first indented between the main ribs and finally separated into distinct segments: which produces the immense variety in the outer shape of closely related leaves, whose ribs and veins nevertheless remain essentially identical. At the same time, the berries of the mountain ash have grown very numerous and bright red in hue, so as to attract the arctic or northern birds, which have a keen eye for

anything like a patch of brilliant colour. If you cut them across the middle, however, you will see that they remain generically apples in structure and architecture: while their cultivated form, the service fruit of the Continent, still bears witness to their common origin by actually assuming the shape of a little brownish pear. From the same central junction, on the other hand, the true pears and apples diverged in another direction, spreading rather southward and eastward, and attaining a tree-like stature, with foliage and fruits better adapted to a lowland existence. Their leaves gradually lost the deep lobes of the wild service-tree, and became regular ovals in shape, marked at the edges by a number of small fine teeth only, as befits denizens of the sheltered dells, with free elbow-room for catching the full flood of the air and the sunlight. At the same time, their flowers grew fewer and their fruits larger, as almost always happens with more southerly species of northern types. Still later, the true pear and the true apple parted company with one another, and with their near allies the Siberian crab and the pyrus japonica. Their real differences are after all very slight: if it were not for the marked flavour of the fruit probably no one would ever think of reckoning them as distinct species.

XXXVI.

SOME ALPINE CLIMBERS.

On the very summit of the moor here, among the mossy clefts of the weathered granite, a few straggling tufts of northern rockcress still manage to keep good their footing on an area not wider in every direction than the circle described by a radius of some four or five hundred yards from the central boulder on which I am sitting. Small as is the patch of ground over which they thus extend, they can doubtless boast a very considerable prehistoric antiquity ; for there is every reason to believe that they and their ancestors have struggled on here in lonely isolation ever since the end of the great glacial era. Nothing adds so much to the romance of natural history as the fixed habit of regarding every separate colony of plants or animals as a tribe or community, necessarily restricted to intermarriage with other members of the same group in the same place ; it almost compels one to ask oneself in each case, how did they first get here, and how did they come to be permanently severed from the main body of their species elsewhere ? Now northern rockcress is by origin a sub-arctic plant, spreading along all the higher ranges of Scandinavia, Russia, and Siberia, with a few isolated outliers among the snowy mountains of southern Europe. Here in

Britain it occurs on the main summits of the Scotch highlands, descends more scantily into Wales or Cumberland, and hardly loiters on upon a few bleak hill-tops in Ireland among the Ulster heights. This moor on which I have discovered it to-day probably represents its furthest southern colony in the British Isles. There was a time, doubtless, when its ancestors spread uninterruptedly over the whole of central Europe, from the Caucasus and the Urals to the Asturias and the Kerry hills; but with the gradual and still continuous improvement in the climate of the northern hemisphere (however a few bad seasons may prejudice us to the contrary), it has been driven to the arctic regions or to the very tops of the higher mountains; and it now survives as a whole series of distinct colonies, between which intercommunication can only be effected at rare intervals (if at all) by seeds carried across the intervening warm tracts through the agency of Alpine birds. So very small a community as this upon whose territory I have just lighted may be regarded as almost certainly self-contained; for the chances of an occasional cross are here so remote as to represent really what mathematicians would describe as a vanishing quantity.

Of course, it might plausibly be argued that this little group of Alpine rock-cresses on this small patch of hill-top may itself be due to such a solitary accident, and that it may very likely have originated from a single seed dropped on this congenial spot. That is quite a possible explanation in any such individual case, and it may, perhaps, even be the right one in this particular instance. But no number of accidents of the kind could ever account for the persistence with which almost every

higher summit in Great Britain or Ireland still presents examples of little isolated groups belonging to the arctic or glacial flora. We know from the analogy of oceanic isles that a fauna or flora entirely dependent upon such waifs and strays is always fragmentary and heterogeneous in the extreme: it contains only those casual members of larger continental groups which are exceptionally easy of transport by wind or weather. But our Scotch and Welsh mountains still preserve in one place or another an immense number of the old glacial plants, without respect to the size of their seeds, the edibility of their fruits, or the suitability of their actual embryos to conveyance by birds or other known means of transport. There is no way of explaining the frequency of their occurrence except by supposing (what we have otherwise every reason to believe) that they once spread over the whole of the surrounding regions, and have been slowly ousted from the lower districts by better adapted temperate lowland forms, so that they now survive only on the higher rocky points which alone suit their northern constitutions. Moreover, they are also for the most part moribund races; they do not belong to dominant types which are now making their way triumphantly over the world, but to types left behind in the struggle for existence; and so, though they may still feebly live on against intruders in their own ancestral haunts, they are hardly likely to fight out the battle against other species if casually dropped into the midst of already occupied and settled districts.

A great many of these stranded glacial flowers still spread widely over the larger part of the Highlands or of the Welsh hills, as in the case of the little creeping

mountain sibbaldia, which forms the main element in the greensward of the Perthshire moors, or again as with the Alpine hawkweed and the common crowberry, which grow abundantly as far southward as the Merioneth cairns. But a more interesting class of glacial stragglers are those which now loiter only on one or two solitary mountain-tops in Britain, and do not again appear until we reach the higher Swiss pastures or the frost-bound arctic plains. For example, there is a beautiful little pink campion, the Alpine lychnis, which grows abundantly only in high latitudes on the Scandinavian coasts, or at great elevations among the Bernese Oberland ; but which nevertheless manages still to hold its own in two isolated patches in Britain—one on the summit of Little Kilrannock, a Forfarshire mountain, and the other on Hobcartin Fell in the English lake district. Our own country has long been so thoroughly explored by collectors that almost every separate station for each rare flower has been familiarly known for two or three generations : and thus it is quite possible to make a complete list of such isolated glacial survivals, perched like the European settlers from the ' Bounty ' in Pitcairn's Island, each on its own domain of a few acres and separated by hundreds or thousands of miles from its nearest congeners in the arctic regions. A complete catalogue would occupy many pages of a big book ; but two or three of the more striking examples may be roughly thrown together in a few words.

A little boggy sandwort, now dying out even in the marshes of arctic Europe, drags on a lonely existence in Britain only among the upland peat of Widdybank Fell in Durham. Another arctic sandwort of mountain

pastures in the colder north survives on the limestone cliffs of Ben Bulben in Sligo, and on a serpentine hill at Unst in the Shetland Isles. One of the northern chickweeds still keeps up its race more bravely under adverse circumstances ; for it spreads over all the tallest Scotch mountains beyond the Breadalbane range, and also maintains its footing in the Irish hills near Bantry : but if we may trust the ordinary analogies, it will gradually be driven from most of these stations till at last it is confined to one solitary chilly summit, where it will slowly die away from generation to generation. The mountain known as the Sow of Atholl, in Perthshire, has thus succeeded in preserving one of its ancient glacial inhabitants, a blue heath known as Menziesia, now rapidly verging to extinction. The Alpine astragalus lingers on in the Clova and Braemar range : its ally the field oxytrope is also confined in Britain to a single spot among the Clova hills. The saxifrages are a very glacial group, and three or four of them are now distinctly becoming more and more rare in individuals. One species at present lingers with us only on the summit of Ben Lawers ; another occurs on the same mountain, as well as on Ben Nevis and Lochnagar ; a third is confined to Ben Nevis and Ben Avers ; a fourth has several Scotch and English colonies, but grows nowhere in Ireland except on the mossy sides of Ben Bulben. So, too, the Alpine sowthistle is confined in these islands to Clova and Lochnagar, while the mountain Lloydia is only known on three isolated summits in the Snowdon range.

Almost all these plants are, in all probability, now actually in course of extinction over the whole world ; certainly they have long been growing scarcer and

scarcer in the British Isles. For example, the beautiful lady's-slipper, by far the most striking of all northern orchids, was once found in several parts of this country; but it now lingers only near Settle, in Yorkshire, and on a single estate in Durham, where it is as carefully preserved by the owner as if it were pheasants or fallow deer. The same thing is true of many other rare British plants, and others, which once occupied a few scattered mountain-tops, have already altogether disappeared. Their retrogression can hardly be set down to the spread of cultivation, for man has done little or nothing as yet to interfere with crest of Ben Lomond or of Scawfell; we must rather account for it by the gradual secular mitigation of the seasons and the slow retreat of the Alpine types before the triumphant march of the central European flora.

On the other hand, the mass of the Scotch highlands is still occupied by a whole flourishing flora of glacial plants, which will require many ages yet before they are finally driven out by the intrusive phalanx of Germanic species. Indeed, to this day it is not too much to say that while the general aspect of vegetation in Devonshire and Cornwall, or in the Killarney district, is now Spanish or Portuguese, and while the general aspect in Norfolk and Suffolk is German, the general aspect in the Perthshire hills is arctic or Alpine. The most northern and most glacial forms are to be found only on a few scattered peaks; but the slopes and the straths are still richly clothed with more vigorous sub-arctic types; with winter-greens and bear-berries; Alpine bartsia and Alpine veronica; the snowy gentian and the arctic butterwort. Indeed, in a land of ptarmigans and white hares we may say that the glacial epoch in its final phase continues among us even yet.

XXXVII.

SOME AMERICAN COLONISTS.

THE commonest weed in this little English garden at the present moment is a small creeping wood-sorrel, with the characteristic shamrock leaf (for wood-sorrel, not clover, is the true trefoil of St. Patrick and of Ireland), but bearing yellow blossoms instead of the pretty lilac-veined petals of our own familiar spring species. It is an interesting little plant in its own way ; for, contrary to all the natural traditions of emigration, it has moved eastward, against the way of the sun, and has come to us across the Atlantic from the broad central plains of the American continent. There is something strange in the notion of a weed from the New World overrunning the fields of the Old, and living down the native inhabitants of more anciently civilised Europe. Of course, we all take it for granted that our own thistles, chickweeds, and groundsels ought rightfully to accompany British wheat and barley to every part of the colonisable world : indeed, the North American Indians call our common English ribwort 'white man's foot,' because they say it springs up naturally wherever the heel of the pale faces has trodden the soil. Sir Joseph Hooker found our weedy English shepherd's purse—itself a colonist from Central Asia—growing abundantly over a solitary antarctic islet ; and traced it finally to a single seed

which must have clung accidentally to the spade used to dig the grave of a sailor, around which the intrusive little plant was observed to flourish in great luxuriance. Such facts as these we all know and expect: it seems fit and proper that the familiar weeds of cultivation should follow civilised tillage on its widening way over the world. But we are more surprised when we find that a good many American weeds have also forced their way eastward—against the stream, so to speak—and have invaded the Old World, *en revanche*, with the potatoes and the maize, achieving such success as to have lived down more than one of their European compeers. In southern France and Italy the number of these eastward immigrants is very considerable; and even in wetter and chillier England, a poor foster-mother for children of the basking American plains, it is far from being either small or unnoticeable. Such cases are not in themselves at all more remarkable than those of the phylloxera, which has already made good its footing in Europe, or of the Colorado beetle, which we are now endeavouring feebly to repel; but they seem more curious at first sight, because the aggressiveness of fixed and unconscious plants is harder to understand than the aggressiveness of locomotive and volitional animal organisms.

Two of these American wood-sorrels, both with yellow flowers, have now made themselves a permanent home in England, and have even conquered their admission within the exclusive lists of the British flora. One of them has long been a universal weed in all hot climates of the globe and in most temperate ones, having followed the tobacco-plant to Syria and Java and accompanied the tomato to all the warmer climates of Mediter-

ranean Europe. In England it appears chiefly in the southern counties, and does not thrive well in the midlands or the north. But some other American weeds have had better luck among us ; such, for example, as the tiny white claytonia, a straggling round-leaved succulent plant, not unlike the garden purslanes. This queer little tufted trailer, a familiar weed in American gardens, has thickly overrun many parts of Lancashire, having doubtless been landed at Liverpool. In another direction, it has effected an entry by the port of London, and spread in abundance over many parts of Surrey, besides making little excursions up the river to Oxfordshire and attacking several of the neighbouring counties on its onward march. It is still rapidly advancing ; and though but a naturalised alien, it threatens before many years to become one of our most annoying and persistent garden-weeds.

A rather pretty American balsam, with orange blossoms spotted with red, has in like manner made itself a firm local habitation on the banks of the Wey and sundry others among the Surrey streams. Then there is the Canadian Michaelmas daisy, long completely naturalised on the Continent, and now beginning to push its way boldly along the grassy margin of southern English roadsides. All these are thoroughgoing weeds, extremely troublesome in America itself as well as in the European countries where they have established themselves ; and they are rendered dangerous by the fact that they come from a very large continent mainly consisting of open prairie, which ensures them excellent weedy constitutions, as the final survivors in an exceptionally severe struggle for existence among highly adapted prairie plants. They have come across to us by

accident as mere weeds, clinging to the tubers or roots of imported food-plants. Somewhat different is the case of ornamental blossoms like the mimulus, originally planted in flower-gardens, but now fairly established as an escape in boggy or marshy ground. Of these handsomer straylings we have several acclimatised varieties; but they do not spread like the regular weeds, nor have they the same strength of constitution which enables the claytonia and the Michaelmas daisy to compete successfully with the old-established weeds of cultivation in southern Europe.

Even more interesting, however, than these aliens, which owe their introduction directly or indirectly to man, are the real natural colonists from America, which are found sparingly in many places along our exposed western coasts, from the Hebrides to Cornwall. Many of them, no doubt, have been acclimatised in Britain long before the discovery of America by the Spaniards; for all the evidence goes to suggest that their seeds must have been carried across the Atlantic by the agency of sea-birds, or must have been wafted over in the crevices of drift-wood, or must have been washed ashore by the favouring current of the Gulf Stream. For example, in the lakes and tarns of the Isle of Skye, Coll, and the outer Hebrides, as well as in the shallow loughs of Connemara and Kerry, a slender graceful water-plant with pellucid leaves grows abundantly over the soft mud, and forms a tufted waving carpet above the smooth shining bottom, with its white jointed fibres and grass-like blades. This pretty weed belongs to a family otherwise wholly unrepresented in Europe, but common in all the still waters of America. Clearly, from the

nature of its distribution here—only along the extreme western belt of the British Isles, where the coast lies fully exposed to the long wash of the Atlantic—it must have reached our shores by some such casual accident as those which have peopled oceanic islands, like the Azores, with their scanty fauna and flora. Its seeds must have clung to the legs of wading birds blown eastward before a northern cyclone, or else its roots must have been torn up entire and cast upon some shelving Irish coast by westerly winds. Similarly, in a few Connemara pools, as well as in two or three Continental stations, another pretty little American water-plant, classically named the naiad, has long grown in isolated colonies, cut off by the Atlantic from the main body of its race in Massachusetts and Labrador. A beautiful small white orchid, too, distantly allied to our common English lady's-tresses, abounds all over the eastern half of North America; but in Europe it is known only in a few bogs in county Cork, where the ardour of modern botanists is rapidly putting an end to its brief European career. This case presents some features of peculiar interest, because the Irish specimens seem to have been settled in the country for a very long period, sufficient to have set up an incipient tendency towards the evolution of a new species: for they had so far varied before their first discovery by botanists that Lindley considered them to be distinct from their American allies; and even Dr. Bentham originally so classed them, though he now admits the essential identity of both kinds. The blue Bermuda grass-lily, again, a common and extremely graceful American meadow-weed, is found in one place only in Europe;

and that is near Woodford, in Galway, where it does not appear to have been introduced by human agency.

It would even have been possible before the days of Columbus for a philosophical botanist of the modern type (had one then been imaginable) to have predicted the existence of the American continent from the occurrence of so many strange plants in isolated situations on the western shores of Britain and Scandinavia. He would rightly have argued that these unfamiliar weeds, not belonging to any part of the European flora, and sometimes even differing wholly from any known family of European plants, must have come with the prevailing winds and currents from some unknown land beyond the sea. That the plants in question grew there even then is highly probable, because most of them bear every sign of great antiquity: certainly they are not likely to have been introduced by man, since the larger number are mere inconspicuous water-plants, which could not come over with cultivated seeds or tubers, and which would not, of course, be deliberately planted in gardens. On the other hand, when once introduced by chance, they would be sure to gain a firm footing; because America, with its enormous stretches of fresh water, in rivers, lakes, and innumerable scattered ponds, is far richer in strong and well-endowed aquatic weeds than relatively hilly and lakeless Europe. This peculiarity is well seen in the career of the Canadian pondweed, which was first introduced into England as a botanical specimen in 1847, and rapidly spread through canals and sluggish waters over the whole of Britain. No European weed can stand against it; and what makes its progress the more remarkable is that it seldom or never

seeds in this country, propagating entirely by its lissom floating rootless branches. Still, the area over which it has made its way, and the centres from which it started — Yorkshire, Leicestershire, Berwick, and Edinburgh— clearly show (what is otherwise well known) that it owes its introduction to human means : while the spontaneous occurrence of the other water-plants in a few lonely portions of the western coasts equally suggests that they owe their transplantation solely to birds or ocean-currents.

XXXVIII.

THE WEEDS OF BEDMOOR.

OUT on the red moor here the sea-breeze blows wet and misty, and the brine may almost be tasted in the fine spray that floats around us, covering the low straggling vegetation of the salt marsh with a thin film of incrusting crystals. For there are moors and moors in England ; and this particular Bedmoor by no means fulfils the prior expectations that might be formed of it from its high-sounding name. To our early English ancestors, in fact, a moor meant almost any tract of wild or unenclosed ground ill fitted by nature for human habitation or tillage. It was as indefinite and as expansive in sense as the Australian word 'bush,' or the Norman equivalent 'forest.' So in Yorkshire a moor means a high stretch of undulating heath-covered rock ; whereas in Somerset it means a low flat level of former marshland, reclaimed and drained by means of numerous 'rhines'—as local farmers still call them, with fond clinging to an old Celtic common name, which has elsewhere grown into the specific Teutonic title of the most German among European rivers. Bedmoor belongs rather to the latter type : a little triangular patch of Dorset coast swamp, cut off from the sea by a narrow belt of coarse shingle, and intersected by numerous

tidal ditches, with occasional flat expansions of fathomless muddy ooze. It is not a beautiful place, truly, in its main features; and yet it revels in a wealth of colour that a painter dare hardly imitate, and a profusion of minute detail that even a Dutch painter could never dream of reproducing on his toilsome canvas.

I spoke just now of Bedmoor as red; and the epithet is really the only one that will exactly fit it at the present moment. It is not purple, like a side of Braemar covered thickly with a great sheet of flowering Scotch heather; nor yet pink, like a bit of the Lizard promontory, clothed from end to end with the flesh-coloured panicles of the Cornish heath; nor is it pale mauve, like a patch of some midland common richly overspread with our ordinary little English ling: it is simply red and nothing else, crimson with the brilliant hue of the Virginia creeper in Magdalen cloisters when the frost first catches its dying foliage in the opening days of October term. Not that the whole expanse is red alike all over: the crimson bits spread here and there in great patches between taller herbage of mingled green and grey. At first sight, even those who know and love the marshy lands would hardly guess what it is that gives these exquisite passages of warm colour to the quiet vegetation of Bedmoor: but when one descends upon the low-lying land itself, the crimson patches reveal themselves as semi-tidal mud-flats overgrown by two common little seaside weeds, glasswort and sea-blite. Even in their green summer dress they are curious and interesting plants; but when the autumn hues begin to tinge them in great masses, as on these muddy reaches among the salt marsh, they

come out in a perfect blaze of deep crimson such as no other English foliage can ever equal. It is not often, however, that they grow together over large enough spaces, unmixed with other weeds, to form the one main element in the coloration of a considerable tract: and what makes Bedmoor at this moment so beautiful and interesting is just the fact that the inundated levels where the glasswort and the sea-blite love to crawl among the soft ooze are here so large and continuous, stretching long arms in and out among the rank brown grasses and fluffy aster-heads that form the herbage of the intervening drier belts. A sluice at the mouth of the tidal backwater shuts off the sea from these naturally flooded branches of the little channel; so that the succulent weeds have it all their own way upon the congenial mud, where they creep and bask in crimson luxuriance without fear of competition from the drier plants of the surrounding meadow.

Taken in its minutest details, the vegetation of Bedmoor is quaint and interesting to the highest degree. Only a pair of skinny horses eat down the taller herbage; while a few lean, lank pigs of dolorous aspect grub hopelessly for tubers along the edge of the slimy ooze. The red weeds themselves are some of the strangest among our native English plants—succulent, cactus-looking seaside denizens, which collect quantities of alkaline material from the saturated soil in whose mud they grow, and which used formerly therefore to be burnt for barilla, in the days when England was more dependent upon home produce for feeding her industries than she is now. That is how one of them got its popular name of glasswort. As they grow together on

the soft bed of the dried pool—Oxford clay well kneaded with salt water—the two weeds look quite indistinguishable from one another; for both share the common succulence of seaside plants, familiar to most of us in samphire and saltwort, and both have turned to the very selfsame shade of red under the influence of their identical conditions. When you pull them and examine them closely, however, you see that there are marked differences in their flowers and their mode of growth. Both belong by origin to the goosefoot tribe; but glasswort is far more degenerate in character than its very similar neighbour. Sea-blite, in fact, can still boast the possession of distinct leaves and flowers, though the leaves are reduced to mere shapeless fleshy branch-like masses, and the flowers are scarcely more than small greenish pulpy knobs. But glasswort has gone much further on the path of degradation; it has lost its leaves altogether, while its flowers have sunk almost indistinguishably into the general mass of its stem. The whole plant looks, accordingly, like a series of jointed pieces, with a little pyramidal cluster of three sunken knobs, representing what were once blossoms, at each joint of the articulated branches. Alone among English weeds, it approaches somewhat in quaintness and oddity of arrangement the great leafless cactuses and euphorbias of tropical deserts.

The other plants that cover the sides of the moor are almost as interesting in their own way as the crimson creeping weeds that spread over the mudbank. The edge of the watercourses is fringed with feathery spear-grass, its cotton-tufted seeds just protruding from the purple scales that hide them. A few late asters

linger on in blossom among them, with lilac rays and yellow centres, like Michaelmas daisies; and thick fleshy leaves, often pickled by country housewives as a poor substitute for that almost forgotten relish, samphire. For the most part, however, the asters are now fully in fruit: each head covered by a fluffy mass of gossamer-winged seeds, that fly away by hundreds with every breath of the misty sea-breeze. No wonder they grow by hundreds on the flats here; seeing that each head produces a hundred seeds, and each seed flies away lightly on its own account to find a fitting resting-place by some similar pool or tidal hollow. On the bank by the confining shingle beach the strawberry clover spreads its ripening heads, which adopt the exactly opposite tactics of protective devices against animal invaders; for the seeds are here enclosed in a little swollen network of calyx-veins, which redden as they ripen, giving the head a rough resemblance to a raspberry rather than to the sister fruit from which it takes its popular name. Altogether, the flora of Bedmoor is rich and tempting. Even the casual passer by pauses on the causeway that carries the road across the moor to admire the brilliant colouring of crimson glasswort and yellow ragwort: the patches of red are on too large a scale not to attract the least observant eye: but to those who love pottering about, with all attention fixed on the beautiful things below, it is a very paradise of native seaside vegetation.

XXXIX.

THOR'S HAMMER.

AFTER a long hunt on a gloomy autumn morning among the prehistoric earthworks which crown the East Cliff, I have come at last across a genuine relic which well repays me for the trouble and discomfort of grubbing in the loose surface-soil amid fog and drizzle. For, unless I mistake, the object which I now hold in my hand, rather grimed with clay and age, but still showing traces of its polished surface through the thick crust of earth, is nothing less than the identical hammer of the great god Thor himself. It is, in fact, a shapely flint axe belonging to the later Stone Age, when men had learned to grind and smooth their tools or weapons; and it once formed a possession of the ancient Euskarian chief whose remains still lie unmolested in the great barrow which forms the central point of the earthwork. For, though the country people call the rough enclosure 'Cæsar's Camp,' an archæological eye recognises at once that its irregular outline could never have belonged to one of the square and symmetrical Roman stations; while the shape of the barrow, which is long instead of round, shows clearly that it was first erected by the aboriginal stone-using race, not by the later and intrusive bronze-weaponed Aryan Celts. If there were any

doubt at all about the matter, this stone hatchet, which is thoroughly Euskarian in type, would set the question at rest in a moment.

But why should I identify this old neolithic weapon with the mythical hammer of the Scandinavian god Thor? The Euskarians are separated in our island from the Anglo-Saxons and Danes by all the long interval of British and Roman times. How can a polished hatchet of the later Stone Age have anything to do with the chief deity of a race who peopled Britain a couple of thousand years after the hatchet itself had been safely buried beside the dead chieftain in yonder barrow? Well, the connection is far closer than one would at first sight be tempted to suppose. We must remember that philology, though it tells us a great deal about the origin of myths, does not tell us everything. Popular superstitions, in fact, do not as a rule gather about language at all, but about certain tangible and material objects, supposed to have a mystical virtue. It may be a crooked sixpence, or a horseshoe, or a bloodstone, or the charms on a watch-chain. It may be a standing stone, or an oak, or a mistletoe bough. It may be Dr. Dee's crystal, or the Lee penny, or the Luck of Edenhall, or the Stone of Ardvoirloch. But whatever it is, it is usually a definite thing, to be seen and handled by all: something, as a rule, which in some way excites one's curiosity, or suggests by the mode of its occurrence a supernatural origin.

Now, objects dug up from the ground, and not known to be of human workmanship, are specially apt to meet with such superstitious reverence. Among them the commonest, in Europe at least, are stone

weapons. We all know already by what gradual steps the neolithic arrows came to be regarded as elf-bolts or fairy darts; but a somewhat different belief grew up about the larger and more formidable-looking stone axes of the same primitive people. It is a universal idea among the scientifically ignorant that lightning consists of a material weapon—the thunderbolt. Hence all large weapons, or objects which look like weapons, found underground, are popularly known as thunderbolts. In districts where big species of belemnites—the bones of a fossil cuttle-fish—occur in any numbers, these lance-like petrifications receive that name. But all over England, France, Norway, Sweden, Germany, Holland, and Italy, the polished stone axes of the Euskarian aborigines are also known as thunderbolts, and believed to have fallen from the sky. Even in countries where the Stone Age has lasted till a recent period the hatchets are already regarded in this light, and viewed with superstitious reverence accordingly. The Jamaican negroes thus regard the beautiful greenstone axes of the old Caribs; and the Canadian farmers give the same name to the finished weapons of the Hurons and the Objibways. In Japan, Java, Burmah, and West Africa the selfsame belief holds good. Everywhere the stone axe becomes a thunderbolt in the popular estimation.

When the old Teutonic and Scandinavian hordes separated from their Aryan ancestors in Central Asia, they carried away with them to their new homes in the forests of Germany or by the shores of the Baltic the primitive religion of the Aryan race. But the great sky-god of the Aryans, the Sanskrit Dyaus, the Greek Zeus,

the Roman Jupiter, whose main function it was to wield the lightnings and gather the clouds, became known and remembered among the Teutonic races as Thunder only. His Anglo-Saxon name of Thunor—from which comes our thunder—is in High German Donner, and in Scandinavian Thor. But the position of his sacred day in the order of the week shows his identity with Zeus; for Thursday, originally *Thunres dæg*, answers of course to *Jovis dies* or Jeudi. Among the Teutons, however, Thunor or Thor is always armed with a hammer; and this hammer, I venture to suggest, is really the stone axe of the aboriginal Euskarians. Men who found such axes in the ground have everywhere leaped at once to the conclusion that they were thunderbolts. What more natural, then, than to figure the god Thunder as armed with such an axe? In fact, we get direct evidence on the subject in the Anglo-Saxon literature itself; for in the 'Exeter Book' the lightning is described as the 'weapon of the car-borne god, Thunor;' while in another contemporary poem the thunder is described as threshing 'with its fiery axe.' When we put all these facts together, I hardly see how we can avoid the inference that the early English and Norsemen formed their conception of Thor's hammer from the stone hatchets which they knew as thunderbolts.

On the other hand, it is curious to note how the two conceptions of the stone hatchet, as the thunderbolt and as a fairy relic, have lingered on side by side. In Scotland, for example, these old weapons are superstitiously cherished in families as talismans for keeping away misfortunes and curing disease. This shows that they are still vaguely remembered as belonging to the elves, who

send sickness and calamities, and whose influence may be averted by possession of an object which once belonged to them. They are believed, in particular, to assist the birth of children—a function with which fairies are always closely connected—and to increase the milk of cows, which fairies are often known spitefully to dry up. But then they are also regarded by these very people as thunderbolts, and supposed to protect the houses in which they are kept against lightning. It is an interesting fact that such heathen superstitions still exist in Presbyterian Scotland more perhaps than in any other part of the British Isles.

Finally, I should much like to know whether stone hatchets have anything to do with those places in England which are still called after Thunor. There is a Thundersfield in Surrey, a Thundersley in Essex, a Thursfield in Staffordshire, a Thursby in Cumberland, and a Thursford in Norfolk, all of which take their titles from the Anglo-Saxon Thunor or the Danish Thor. Near Thursley, in Surrey, is a Thunder Hill. Now, as we see that the names of the fairies cling about those places where stone arrows or elf-bolts are abundant, it would be interesting to learn whether any large find of stone hatchets has ever been discovered at any of these towns or hills, or whether any long barrows occur in their neighbourhood. Of course it is possible that the names may only be due to some old heathen temple or meeting-place ; but it is also possible that they may be due to actual visible tokens of Thunor's presence found upon the spots in question.

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